Quarterly Technical Progress Report

Project Title: OTEC Lifecycle Cost Analysis

Covering Period: January 1, 2010 to June 27, 2010
Date of Report: July 30, 2010

Recipient: Lockheed Martin
Award Number: DE-EE0002663

Working Partners: Makai Ocean Engineering, John Halkyard and Associates: Glosten Associates, Planning Solutions, Inc., G. Noland and Associates, Inc.
Cost-Sharing Partners: N/A
Contacts: N/A

DOE Project Team:
DOE HQ Program Manager – Jacques Beaudry-Losique
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DOE Field Contract Specialist – Fania Gordon
DOE Field Project Officer – Tim Ramsey
DOE/NAVARRO Project Monitor – Samantha Quinn

Project Objective: Perform an economic analysis of the OTEC cost of electricity (COE) to generate a set of Energy Supply Curves for OTEC plants of the future.

Background: The capital investment required to build OTEC plants requires a sound understanding of the economic factors and achievable cost of energy.

Status:
The OTEC Life Cycle Analysis project was awarded in March. During the second quarter of 2010, contractual relationships were established with all project members. A responsibility matrix was established to define each project members' area of responsibility, required inputs from other project members and outputs to be produced. The responsibility matrix was reviewed and agreed to by all project members providing a solid base of understanding for the work to be performed on the project.

Plans for Next Quarter:
During the next quarter, a detailed project schedule will be developed and each project members' tasks kicked off.

Patents: No patents apply to this project.
Publications / Presentations/Travel: No disseminations occurred in this quarter.

Project Schedule & Milestones **DE-EEXXXXXX**

Task Number	Title or Brief Task Description (EXAMPLES)	Task Completion Date				Progress Notes
		Original Planned	Revised Planned	Actual	Percent Complete	
1	Establish Responsibilty Matrix	May-10		Jun-10	100%	Complete
2	Issue Subcontracts	Jun-10		Jun-10	100%	Complete
3	Task 1.0 Near Shore Baseline	Oct-10			0%	
4	Task 2.0 Offshore Baseline	Jan-11			0%	
5	Task 3.0 Technology Development	Mar-11			0%	
6	Task 4.0 Environmental Cost Assessment	Apr-11			0%	
7	Task 5.0 Life Cycle Cost Assessment	Apr-11			0%	
8	Task 6.0 Economic Analysis	Jul-11			0%	
9	Final Report	Sep-11			0%	
10						
11						
12						
13						
14						
15						

Spending Summary			TO	FROM
		Project Period	01/01/10	12/31/11
		Current Quarter	01/01/10	06/27/10
Object Class Categories (Per SF424a)	Approved Budget	Project Expenditures		
		This Quarter	Cumulative to Date	Est. Costs Next Quarter
a. Personnel				
b. Fringe				
c. Travel				
d. Equipment				
e. Supplies		REDACTED EXEMPTION 4		
f. Contractual				
g. Construction				
h. Other				
i. Total Direct Charges				
j. Indirect Charges				
k. Totals (sum i +j)	$499,701	$15,737	$15,737	$118,000
DOE Share	$499,701	$15,737	$15,737	$118,000
Recipient Cost Share	$0	$0	$0	$0
Calculated Cost Share Percentage	0%	0%	0%	0%

Cost Share Contributions						
Funding Source	Approved Cost Share		This Quarter		Cumulative to Date	
	Cash	In-kind	Cash	In-kind	Cash	In-kind
Not Applicable						
TOTAL	$0	$0	$0	$0	$0	$0
Cumulative Cost Share Contributions						

U.S. DEPARTMENT OF ENERGY, GOLDEN FIELD OFFICE

Advanced Water Power

FUNDING OPPORTUNITY ANNOUNCEMENT NUMBER: DE-FOA-0000069

Announcement Type: Initial

CFDA NUMBER: 81.087

Topic Area 3: Advanced Water Power Market Acceleration Projects/Analysis and Assessments

SUB-TOPIC AREA 3C: OTEC LIFE CYCLE COSTS ANALYSIS

4 JUNE 2009

SUBMITTED BY:

LOCKHEED MARTIN

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1. Project Objectives

This proposed work develops OTEC plant costs and Operations and Maintenance (O&M) costs to establish the Life Cycle Costs for nearshore and open ocean grazing OTEC systems. The Lockheed Martin (LM) Team has been working on developing a first commercial OTEC plant for the past 2-1/2 years and thus has tremendous resources for accurately developing these costs and a high interest and commitment in the results. This proposal lays out our extensive OTEC experience and how we intend to leverage that knowledge and expertise to deliver a responsibly accurate and comprehensive estimate of the future cost and quantity of OTEC power.

LM Team Members and Expertise

Team members and their associated expertise are described in Figure 1.1. Further details regarding each team member can be found in section 5, Qualifications and Resources.

Team Member	Expertise
Lockheed Martin	Systems Prime, Life Cycle Cost Analysis, Risk Analysis and Mitigation
Makai Ocean Engineering	Ocean Engineering, OTEC Systems, Large Diameter Pipes, Marine Ops.
G. Noland & Assoc. Inc.	OTEC Systems, Renewable Energy, Financial Analysis,
Planning Solutions Inc.	Environmental Compliance, Impact Assessment, Federal and State permits
John Halkyard & Assoc. Inc.	Offshore Platforms, Offshore Oil Industry Operations
Glosten Associates	Naval Architecture, Financial Analysis, Marine Engineering

Figure 1.1 *Our Solid Team and Extensive Prior Work Assures Project Success*

Statement of Project Objectives

The LM Team proposes the following objectives for the OTEC Life Cycle Cost Analysis Study:

1. Modify our current grid-connected OTEC design and cost estimates for application at multiple locations and OTEC sizes.
2. Extrapolate our grid connected OTEC cost estimate to grazing OTEC plants
3. Identify start up costs.
4. Identify how OTEC is likely to evolve in the future for lower cost and higher performance.
5. Define the required permitting and environmental compliance costs and schedule
6. Develop Life Cycle Cost estimates for the baseline OTEC system
7. Perform an economic analysis of the OTEC cost of electricity (COE) as well as generating Energy Supply Curves for OTEC plants of the future
8. Make the results of this work available to the public by publishing it on the Internet and by preparing and presenting technical papers on the results.

Cross Reference Matrix of FOA Requirements to Proposal Section

A cross reference matrix showing where each requirement in the Funding Opportunity Announcement (FOA) can be found in our proposal is located in Section 6 on page 20 of this proposal.

2. Technical Merit and Innovation

Recent energy price volatility and an increased commitment to renewable energy and energy security by both public and private sectors has renewed interest in Ocean Thermal Energy Conversion (OTEC). With increased incentives and with the technology changes over the past three decades, what is the cost of OTEC power and how much power can be produced? Answering these questions by determining the life cycle costs of OTEC power under varying operational and technology development scenarios is the focus of this proposed work.

Ocean Thermal Energy Conversion, a process that produces electricity from the temperature differences in tropical ocean waters, is a very attractive alternative energy; OTEC is baseline power, is a clean energy source producing no direct carbons, is environmentally sustainable, and is capable of providing massive levels of energy many times the total world's electrical production today. OTEC is among the world's major renewable energies and stands out among the others in terms of size, high capacity, and non-interference with other uses for land, water and food. This immense attraction for OTEC is dampened only by the relatively high cost of OTEC plant development and construction. This financial obstacle, and the relatively low cost of conventional energy, has prevented commercialization in spite of the heavy R&D investment in OTEC by DOE in the 1970's and 80's.

This study will identify the most likely cost of electricity from future OTEC plants. Two baseline OTEC operational scenarios are to be considered in this study:

- **Nearshore OTEC** plants could supply electrical power via undersea umbilicals to island and coastal communities in tropical waters. Islands such as Hawaii, Puerto Rico and Guam could have all their electrical (and land transportation) needs provided by OTEC – a total of 5000 MW or more. This is a sizable high-end market that is ideally suited for initial OTEC application and development.
- A much broader national impact for OTEC can be realized by building an OTEC industry consisting of very large OTEC plant ships manufacturing an energy carrier and operating in equatorial regions (where temperature differentials are a maximum and adverse storms do not exist). This **offshore OTEC** industry could provide large quantities of renewable energy to the continental US via the energy carrier. This application requires a lower-cost OTEC plant to compete in a wider market.

This project goal of defining the lifetime cost of OTEC power is of critical interest to the Lockheed Martin Team who have been working on OTEC commercializaton and costs for the past two and a half years. It is the largest and most focused effort underway in the US and significant progress has been made:

1. Lockheed Martin has hand picked a team of experts on all the key technologies and business aspects of developing OTEC. The team consists of specialists within Lockheed Martin and within the OTEC, marine and offshore oil and gas communities.
2. We have identified key technical and cost challenges of OTEC commercialization and have focused our efforts on those issues. There are design teams for the platform and mooring, the cold water pipe, the OTEC module, the heat exchangers, the power systems, the electical transmission to shore and business development. Lockheed Martin's system integration specialty is being used to coordinate and lead this complex project.
3. We have conceptually designed a 10 MWe Pilot Plant and have developed a detailed cost estimate (18 categories and 325 cost items) for that plant. To achieve accuracy, these costs have been developed by experts on the various components and processes involved in an OTEC plant.
4. We have a notional cost and design for a 100MW commercial plant and this year our team is focusing on refining that design and cost.
5. We have a platform concept that is an offshoot from the offshore oil industry and we have used the latest offshore platform analytical tools to confirm safe platform, pipe and mooring dynamics under hurricane conditions.
6. We have been in extensive discussions and plant visits with manufactures of key OTEC components such as heat exchangers, platforms, water pumps, transmission cables, ammonia pumps, turbines, etc.
7. We have commenced detailed design, prototype fabrication and testing for the heat exchangers. A heat exchanger corrosion and performance testing facility is being built at the Natural Energy Laboratory of Hawaii Authority (NELHA) with support from NAVFAC, ONR, and NELHA.

8. We have detailed designs and plans for the at-sea fabrication of a unique FRP pipeline and a prototype fabrication of that pipeline is underway with DOE participation.
9. Ongong technical interface negotiations with Hawaiian Electric Company are being used to define customer requirements.
10. We have created business development plans for a vareity of OTEC development scenarios.

Thus we are already a team of experienced and professional OTEC engineers, scientists, planners, and managers who have been and continue to work on OTEC development with the stated objective to commercialize OTEC as quickly as possible. We bring considerable past experinces and current technical and costing work for accomplishing this project. As a result, this proposed work is highly leveraged with an extremely high value to DOE. The above efforts, all focused on achieving low cost but low risk commercial electrical production are the results of over $10 million invested to date and provide invaluable added value.

We propose to develop and describe notional designs, performance and costs for both the nearshore and offshore OTEC baselines based heavily on recent OTEC work performed by our team. For the offshore OTEC, we plan to extend the ONR SBIR work recently completed by Makai Ocean Engineering on defining the performance and cost of a large offshore OTEC industry. We will integrate in the latest capital costs and operational understandings from the ongoing 100MW plant ship designs, extrapolate from these

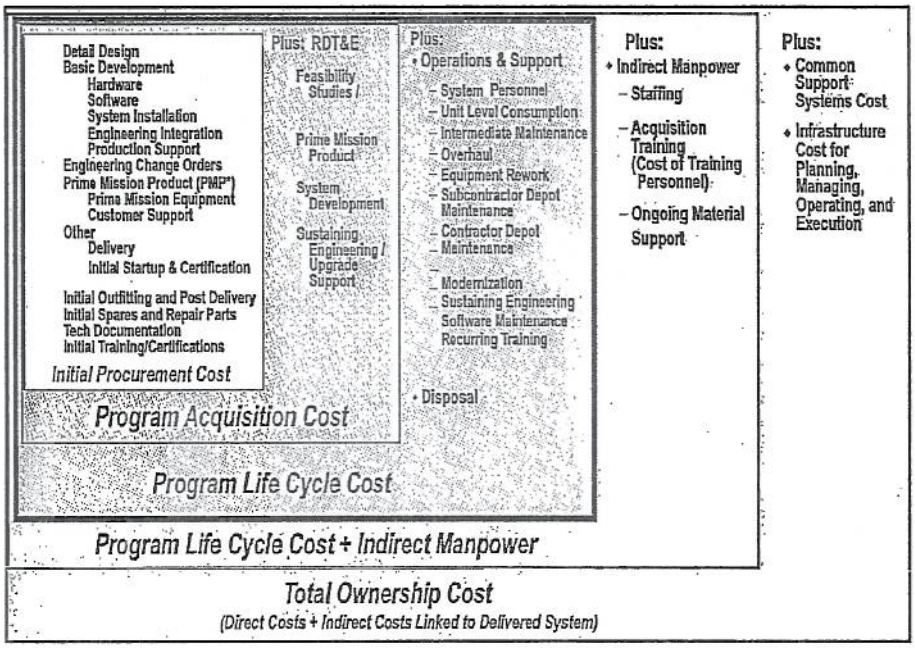

Figure 2.1 *Lockheed Martin Team Total Ownership Cost (TOC) / Life Cycle Cost (LCC) Analysis Diagram*

baselines, and will apply the Total Ownership Cost / Life Cycle Cost analysis as shown in Figure 1.1 to derive future O&M and life cycle cost. For each baseline, several scenarios will be evaluated to develop energy supply curves. The following section provides the details on how we propose to provide the most accurate, pragmatic and comprehensive economic forecast possible.

3. Technical Approach and Project Research Plan

The following paragraphs describe the LM Team technical approach and project research plans for each of the six tasks proposed under the OTEC Life Cycle Cost Analysis. The task objectives are stated at the beginning of each task description followed by our technical approach and the research plan to accomplish the work.

Task 1: Near Shore Grid Connected Baseline

Objective: define the baseline scenario and the capital cost requirements for a near shore grid connected OTEC plant and determine capital cost variations for several plant sizes and locations.

Grid connected OTEC plants supplying base load electrical power to locations such as Hawaii, Puerto Rico, Guam and potentially Florida have been the initial target of our team's ongoing OTEC effort (see previous section). This task will expand upon this ongoing work and define the capital costs for 50MW to 300MW OTEC plants located at these various locations.

A primary tool to be used in this task and subsequent tasks will be an integrated OTEC design and cost model. Makai Ocean Engineering developed an OTEC sizing, optimization and cost tool under a just-completed phase II ONR SBIR entitled "Integration and Optimization of Hydrogen Production with Ocean Thermal Energy Conversion Technology in Offshore Floating Platforms." Makai developed an extensive OTEC model that includes both engineering and economics. The model is an accurate conceptual OTEC design and is extremely valuable for comparing various OTEC configurations and for optimizing a given OTEC system. Optimizations are based on the levelized cost of power – the most significant driving factor in OTEC. This model has been calibrated for cost and design with oil-industry platform designers and, on a large scale, with the latest Lockheed Martin 10 and 100MW designs and cost estimates.

An expanded number of cost categories will be added to this model to more accurately predict capital costs over a wider range of plant sizes, locations, and thermal resources. The detailed cost estimate for the capital cost of the Lockheed Martin OTEC plant contains 315 categories; these will be grouped by function and by scaling parameters to enable a means of estimating capital costs and optimal designs for OTEC plants of different sizes and under different operating conditions.

There is a large economy of scale with OTEC; small plants are more expensive per kW than are large plants. In the case of 10MW vs 100MW, Figure 3.1 shows the smaller plant is overall three times more expensive per kW than is the larger plant. Focusing on the detail, the platform, mooring and cables are proportionally much more expensive for the smaller plant while heat exchanger $/kW are nearly the same. Scale is a major factor in OTEC electricity costs.

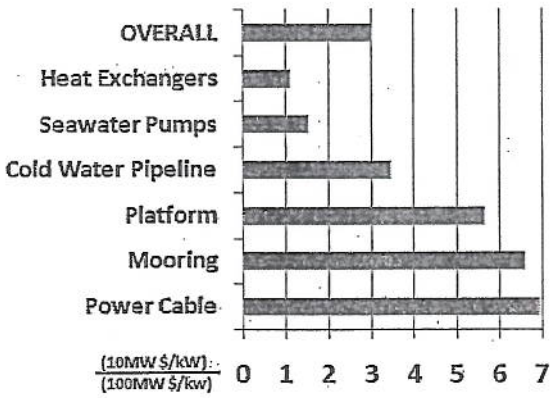

Figure 3.1: *The unit costs of a 10MW OTEC plant relative to unit costs for a large 100MW plant. Small plants are proportionally much more expensive than large plants.*

The OTEC capital cost estimates will be coordinated with and checked by Glosten Associates. Glosten has coordinated the detailed pricing of the Lockheed Martin Team's OTEC designs to date and adds hard offshore experience both in design and pricing. The Glosten costs are based on basic materials and labor; commodity prices during the last several years have demonstrated an unprecedented level of volatility in world markets. Statistical derivatives of commodity pricing will be among the factors used to develop high, low and expected cost models.

The final goal of this task is to define OTEC plants and capital costs for different regions with varying power capacities. Each of the four baseline locations has a different OTEC environment. Water temperatures, seasonal variations, design storm conditions, distances from shore, and the maximum OTEC plant size are unique at each location. For example, OTEC off Florida would be very large plants to meet the huge onshore demand but the distance offshore will be large, design costs for currents high, and the

seasonal thermal variations significant. In Hawaii, smaller plants are needed to match the local grid but ocean conditions are more favorable throughout the year.

Task 1 Products

- Baseline capital costs for grid-connected 50, 100, 200 and 300MW OTEC plants
- Baseline costs and performance variations for various island locations and Florida.
- Estimated variations in the baseline capital costs due to commodity prices.

Task 2: Offshore OTEC Industry Producing an Energy Carrier

Objective: define the baseline scenario and the capital cost requirements for a large offshore OTEC system manufacturing an energy carrier and transporting that carrier to the continental US.

Very large quantities of OTEC power can be provided to the continental US with offshore OTEC plants located in tropical waters, producing an energy carrier such as ammonia, and transporting that energy carrier to US ports. This task will define that system and provide capital costs. This OTEC scenario is important for developing a large-impact OTEC energy supply curve.

Such a task is immense. Fortunately, much of the work for this task has already been completed by Makai Ocean Engineering in their ONR SBIR work (assisted by Lockheed) cited above.

In this study, an OTEC industry was sized, described and priced that provides large quantities of ammonia (or hydrogen if broken down) to the continental US. This energy is generated in the equatorial regions of the Western Pacific, Eastern Pacific and West Atlantic regions as shown in Figure 3.2.

OTEC done on this scale will involve very large OTEC plantships that will likely be grazing in equatorial

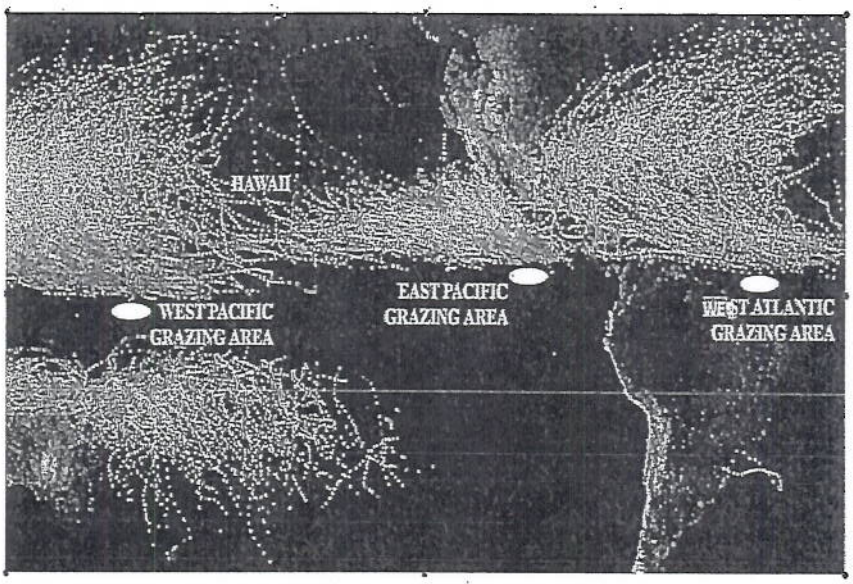

Figure 3.2 Three OTEC Grazing Areas Relative to Historical Storm Tracks

waters. Ammonia will be stored on the plantship or on adjacent Floating Production, Storage and Offloading (FPSO) -like tankers. The primary differences from the near shore gird connected OTEC plants are the (1) ammonia production and storage and thus new processes on board with a larger platform size and complexity, 2) grazing operations and thus propulsion and mooring differences, 3) storm-free equatorial regions and thus milder platform dynamics, and (4) the collection and transport of ammonia to shore and thus a large transport fleet. Figure 3.3 shows the OTEC-Hydrogen Industry Concept using ammonia as an energy carrier.

A strong case for ammonia as an energy carrier as opposed to hydrogen has been made by several researchers: ammonia has a higher energy density when including the container, the energy cost from production to user is lower, and the containment and transport is easier and state-of-the-art. This was the conclusion in the Makai/Lockheed study for ONR.

Ammonia will be used as the energy carrier in this study; the full rational for this selection will be provided as part of this task deliverable.

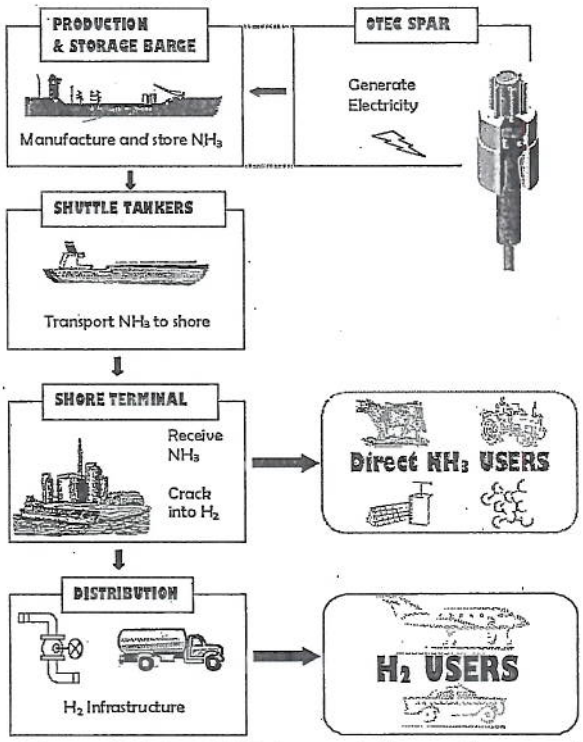

Figure 3.3 *OTEC-Hydrogen Industry Concept with Ammonia as an Intermediate Energy Carrier*

This proposed work will build upon prior work, refine the estimates based on more recent OTEC work performed by our team, refine the plant configurations, review and expand on the storage and transport portion of the study, and identify limiting factors in expanding energy production. In light of the recent work on OTEC design by the Lockheed Martin team, this past study will be revised to reflect the latest cost estimates and technologies for the cold water pipelines, platforms, and heat exchangers. The systems will be configured for operation in a grazing scenario with large available temperature differentials and low storm conditions. Glosten Associates will be used to review the OTEC costs and, in particular, the large scale up of the plants and the transport of the energy carrier to shore. The knowledge gained over decades of transporting Liquefied Natural Gas (LNG) and Liquefied Petroleum Gas (LPG) by ship will form the basis of the cost of transportation of ammonia to centralized distribution points; the Lockheed Martin team will derive freight rates from current and historical data from the LNG and LPG trades. The envisioned industry and its operation will be described and the capital costs will be estimated.

Task 2 Products

- Definition and sizing of a notional offshore industry supplying ammonia to the continental US.
- Capital Costs for unit OTEC plant, storage facility and transport units for this industry.
- Estimated variations in the capital costs due to future price uncertainty and R&D.

Task 3: Technology Development Program and Costs; Potential Technology Evolution

Objective: investigate technology needs for early systems and likely technology changes as OTEC matures.

There are several technologies that need developing before a large commercial OTEC plant can be built. The LM team is focusing on many of these key technical issues such as the cold water pipeline, heat exchangers for seawater applications, and platform designs. For an offshore OTEC industry, the technology startup hurdles are expanded to include ammonia production and significantly different operational scenarios and plant configuration. These developments are upfront costs that are a major part of total cost. This task will identify and describe significant technology developments that require additional R&D costs over and beyond normal plant design costs. The investment costs for these technologies will be estimated in this task.

OTEC will also evolve due to both opportunity and need. Plants that are envisioned today reflect today's understanding of plant layout, operations and maintenance. The OTEC plants that will make up the offshore

OTEC industry, being decades into the future, and having the benefit of many nearshore OTEC deployments in advance, will have evolved into more cost effective and efficient plants. This happens in every product and industry, OTEC will not be different. How are these OTEC plants likely to evolve and what will be the cost impact?

The design decision process for the major cost components of the OTEC plants (both nearshore and offshore) will be reviewed to look at opportunities for cost reduction. Today's designs are driven by today's understanding of risks and, particularly for a high cost public utility OTEC plant, the designs are conservative. However, these designs evolve and that evolution will be driven by cost saving opportunities. This step will look at opportunities for reducing OTEC costs once the major risks of the first few plant operations are retired. For example, an OTEC plant today is designed to have nearly all major components accessible for repair and that is driven by an unknown repair need. Heat exchangers in particular are designed for access and maintenance because of unknown operational hazards. Once those risks are retired and a heat exchanger can be confidently expected to have a long service life, the platform could become more streamlined.

This task will identify major changes that could be made to an OTEC plant to reduce costs, assess the economic benefit to that plant, and discuss the technical likelihood that such a technical innovation will become real. One example will be in heat exchanger cost and performance improvements. Lockheed Martin is working on a new heat exchanger design involving carbon foam technology. If successful, the total cost of today's envisioned 100MW OTEC plant could be reduced by nearly 25%. Other examples are the cost of electrolyzers to separate hydrogen from water which is then use to manufacture ammonia, or the direct synthesis of ammonia – a new proposed process. Such improvements will be needed by future OTEC plants, particularly those providing energy to the continental US.

Task 3 Products

- Identify areas requiring start-up R&D and cost estimates for OTEC specific programs.
- Discussion on likely areas for future cost per MW evolution on OTEC plants.
- Expected changes in capital cost per MW due to evolution.

Task 4: Environmental Cost Assessment

Task 4 objectives are to define broad environmental concerns including permitting, licensing, and monitoring and establish a environmental cost assessment for an initial and subsequent OTEC plants.

OTEC presents unusual challenges for environmental impact assessment and permitting. Technically, there no precedents for the very large flows of deep and shallow seawater that provide the temperature differential for power generation and also result in the most significant environmental impacts of the technology. Environmental impact assessment for systems significantly larger than 10 MWe depends on oceanographic and hydrodynamic models that have not, to date, been adequately developed or tested.

Legally, the permitting requirements for OTEC are also poorly defined. The OTEC Act of 1980 (42 USC §9101 et seq.) designates the Dept. of Commerce National Oceanographic and Atmospheric Administration (NOAA) as the regulator for this industry, but the regulations originally promulgated for NOAA regulation of OTEC were rescinded in 1996. Currently, there are no Federal regulations in place to license OTEC developments.

Early OTEC plant initiatives will need to resolve both of these major areas of uncertainty, hopefully without incurring unacceptable costs or delays. The objectives addressed here are (1) to develop estimates of the costs required to complete the technical studies and permitting efforts necessary for adequate environmental assessment, permitting, and monitoring; and (2) to identify the regulatory measures that must be completed before OTEC can develop without unreasonable uncertainty and delays.

PSI will update and extend the existing cost estimates for a 10 MWe OTEC plant in Hawaii to estimate the costs for 100 MWe and larger plants in Hawaii, Guam, and Puerto Rico. To estimate the additional costs to be expected for the offshore, floating plants, PSI will use as a model the costs associated with commercial liquid natural gas and ammonia carriers.

Task 4 Products

- Estimated Costs for Permitting and monitoring and identification of the major cost components
- Estimates of how these costs will change between the first and subsequent OTEC plants.
- Estimated costs of permitting and monitoring of the energy carrier transport and description of basis for these costs.

Task 5: OTEC Life Cycle Costs Analysis

Objective: develop Life Cycle Cost estimates for both nearshore OTEC Plants with outputs cabled directly to the electrical power grid ashore and open ocean grazing OTEC producing ammonia.

The LM Team has been developing an initial 10MWe near-shore, grid-connected OTEC Pilot Plant design in addition to a proposed design for the first 100MWe OTEC Commercial Plant. The Cost Estimate for the 10MWe pilot plant has been generated and a financial analysis has been performed. Further analysis of the Life Cycle Costs (LCC) for future OTEC plants will be accomplished by leveraging this existing design and associated cost estimates. To refine the estimates, additional high-level Reliability Analysis of the current design is planned. This will serve to validate projected Operations & Sustainment (O&S) costs of the design, which can then be used to further refine the design and also rolled back into the model to increase the credibility of the cost estimates provided through this task. The process flow envisioned for this task is depicted in Figure 3.4. The model created will be a dynamic, reusable model, built on the commercially-available PRICE® series of cost model tools, and will be capable of continual enhancement and refinement as OTEC technology and operating environment characteristics mature over time.

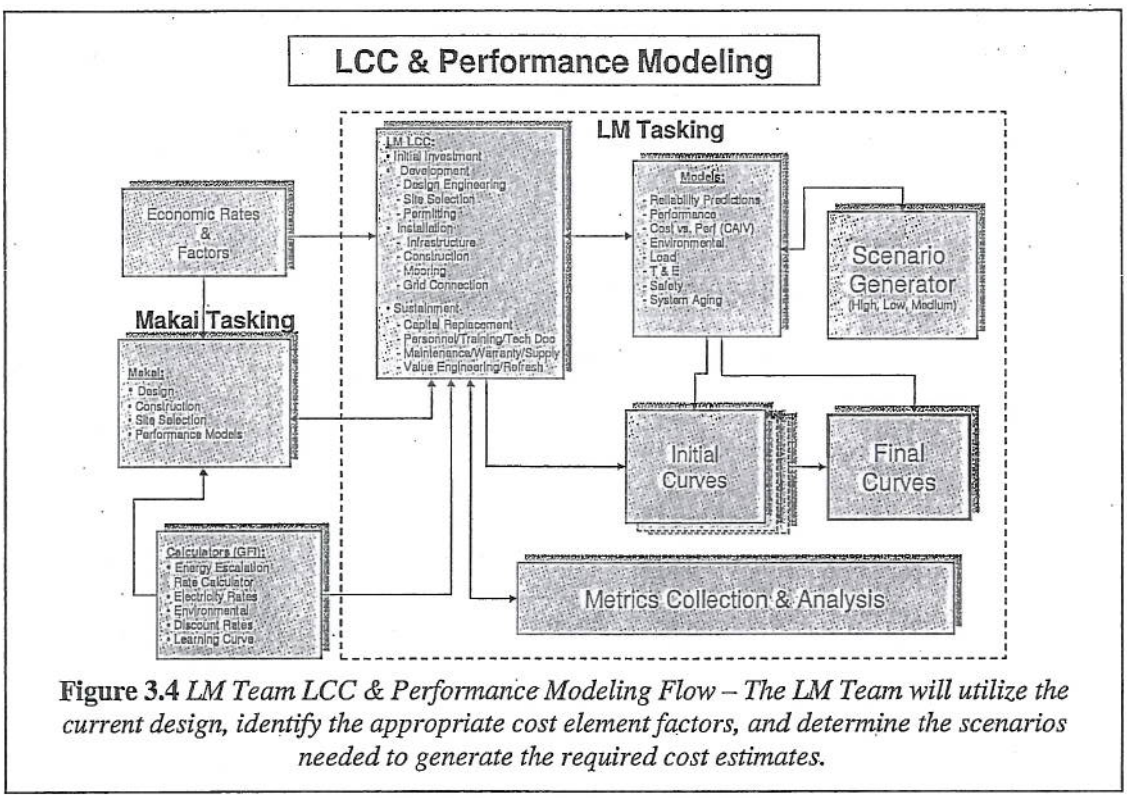

Figure 3.4 *LM Team LCC & Performance Modeling Flow – The LM Team will utilize the current design, identify the appropriate cost element factors, and determine the scenarios needed to generate the required cost estimates.*

The LM Team understands that LCC is a subset of the Total Ownership Cost of a system, which is comprised of the costs to Design, Develop, Product, Operate, Sustain, and Dispose of a system. A properly performed LCC analysis also supports the proposed system specification development, risk identification, and risk management processes. The goal of which will be to ultimately identify and further quantify the best value solution. This will be the optimum combination of performance, risk, schedule, and cost, as defined in conjunction with customer requirements.

The LM Team has extensive practical LCC experience—from small, but complex systems, to diverse, energy-related systems via LM's corporate involvement in the Solar Energy field, to entire, large platform-level systems. Naturally, true to our heritage, we initially draw from experience performing LCC on the recent, and highly-successful, Littoral Combat Ship (LCS) program. In addition to being a large, platform-level program, it also provides numerous parallels to OTEC in that a ship system design contains elements categorized in Department of Defense environments as "HM&E"; Hull, Mechanical, and Electrical; entities such as turbines, generators, pumps, and control systems, which typically combine mechanical, electrical, as well as software components. Overall, these are very similar items to those planned for use on typical OTEC system. Across the diverse corporation, there are numerous program experiences and resources to draw on from areas such as F-16, F-117, AEGIS, Space and various other Weapons programs and provide a good basis for our estimates.

Lockheed Martin utilizes a proven LCC Analysis process, as shown in Figure 3.5. LM also understands that OTEC is still a relatively new technology, therefore the process will remain a living document, allowing the flexibility to evaluate and modify the process, as-required, specifically for OTEC as this technology and the environment it exists in, matures over time.

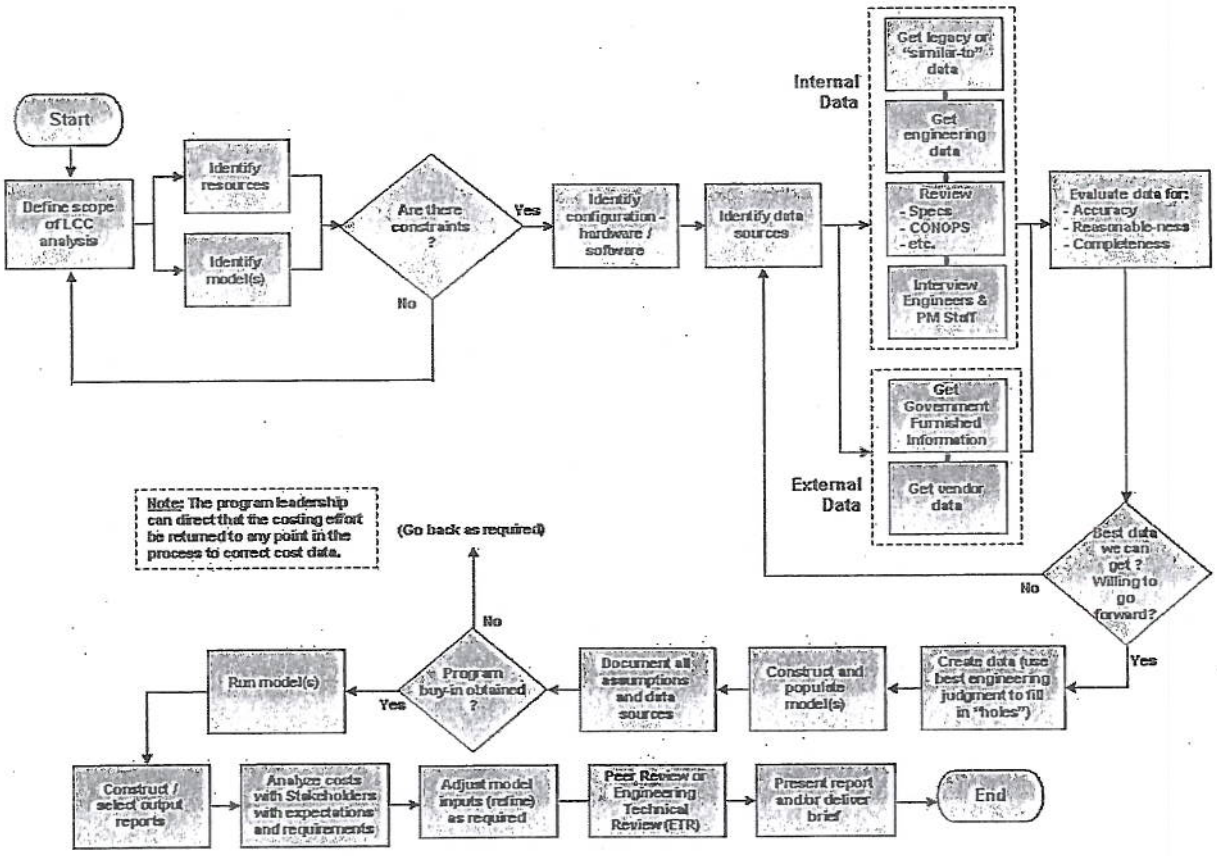

Figure 3.5 *LM LCC Estimating Process Flowchart – An established process, utilizing proven tools, and practical experience provide for optimum success.*

It is also well known that any model, Life Cycle Cost or otherwise, is only as good as data that is input into it, and that there are many factors that need to be understood, validated, and utilized properly. Although a complex environment, the LM Team possesses the experience and controls to simplify the task and ensure the proper data cost elements are applied. Figure 3.6 shows an example of the types of data and interdependencies needed performing a LCC Analysis.

Figure 3.6 *Critical LCC Factors for Consideration - Interdependencies of program data drives the need for a structured approach to Life Cycle Cost Estimating and Analysis*

As a result of the LM Team possessing a mature design providing realistic and credible non-recurring Capital costs, a mature and proven LCC process, experience with the process and the tools to be utilized, the LM Team is ideally suited to perform a thorough and traceable OTEC Life Cycle Cost Analysis. These combined resources enable the LM Team to deliver the required High, Medium, and Low cost estimate curves to accurately bound the costs and provide the rationale for each scenario.

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Task 5 Products

- Identification of the cost elements required for initial OTEC LCCA
- High level Operations and Sustainment (O&S) concept for use in initial LCCA
- Assumptions for future-state elements needed to drive the High, Medium, and Low estimates
- Basic cost model framework that can be built upon for future OTEC LCCA efforts.

Task 6: OTEC Economic Analysis

Objectives: 1) perform a financial analysis of the cost of electricity (COE) for the near-shore OTEC Plant and the open ocean grazing OTEC plants*, and 2) develop Energy Supply Curves for *nearshore OTEC Plants providing power to island grids like Oahu and also a fleet of grazing OTEC Plants producing an energy carrier for* transport to *the continental US.

Part one of the economic analysis of nearshore OTEC will use 100 MWe OTEC Plant for Oahu as the basis for this analysis. The financial analysis contained in the LM internal OTEC Business Plan uses capital plant cost estimates that were developed by extrapolating the detailed cost estimate for the 10 MWe Pilot Plant to the 100 MWe Commercial Plant using appropriate scaling factors for each major subsystem. Replacing these estimates with a bottoms-up cost estimate provides much greater confidence level in the nearshore economic analysis for this study. In addition, the operations and maintenance costs as well as the permitting and environmental compliance costs in the LM Business Plan were estimated by the authors without the benefit of a detailed analysis of these important areas. Thus, the results of Capital Cost Estimate of a Grid Connected OTEC (Task 1) plus the results of the Environmental Cost Assessment (Task 4) plus the results of the Life Cycle Cost Analysis (Task 5) will all be input to the existing financial model under this study. The resulting financial analysis will have the needed fidelity and high confidence level for the OTEC Life Cycle Cost Analysis. This data will then be used to help establish the Energy Supply Curves for the nearshore OTEC and the grazing OTEC and energy carrier system. G. Noland & Associates, Inc. was the principal author of the LM OTEC Business Plan and also developed the detailed financial models used in the plan and will be responsible for performing the work of Task 6.

A detailed financial model for the OTEC Project has been developed to aid in analysis of the business case and help develop realistic scenarios using the best data and estimates form the technical and business portions of the Lockheed Martin team. The Financial Model is Excel-based with twelve separate spreadsheets as shown in Figure 3.7.

Spreadsheet	Purpose
Project Summary	Input page for certain fundamental system parameters and also draws information through links from the other worksheets
Sensitivities	A handy mechanism for doing top level "what if" analyses
Pro Forma	Calculates estimates for the Income Statement, Cash Flow, Balance Sheet, and Sources & Uses of Cash for the OTEC Project from 2013 to 2037
Unit Ops	Calculates operating statistics for the OTEC plant and also calculates escalation capacity and energy charge, labor and O&M variable and fixed costs.
Project Cost	Displays estimates on a monthly basis over a four-year period for cost elements associates with establishing the OTEC business
Financing	This spreadsheet presents the financing requirements from a credit analysis standpoint using Debt/Equity Ratios and EBITDA, required Letters of Credit or cash deposits, and plots financing tranches over the debt term covered by the Pro Forma.
Ops Costs	Estimates to operate and maintain the OTEC plant including labor estimates, G&A, insurance, property taxes, fixed O&M costs, and major overhauls of key components
Acquisition Budget	Estimates for business acquisition activities during the forty-eight month OTEC business and system development period. These costs include professional management, overheads, permitting engineers, consultants and various legal fees.

Pro forma – 20-year Pretax Cash Flow	An important simplification in the 20-year Pretax Cash Flow Pro forma is that it uses cash flow of this project to determine if a private commercial financing approach is feasible for this transaction.
Sources and Uses of Money	Upon receipt of the permits to install, the sponsors would transition into a more typical project financing. We have assumed that 70% of the total transaction cost use transaction documents and assets to secure the debt. The balance of 30% would come from the already invested equity from the development phase if not having already been repaid back to originating sponsors.
Interest Rate Sensitivities	The model provides for an input of an interest rate assumption for both the construction period and the term loan period. As noted in Section 7.8, an 8% all-in interest rate has been assumed. This can change based on the underlying cost of money changing, the 10-year Treasury, or if the risk premium being charged by the lender adjusts.
Debt Leverage Sensitivities	The assumption for the ratio of debt to equity in the model has been 70/30. The assumption in the 70% base case provides 2.0x time coverage of annual debt service from the annualized cash flow before distributions.

Figure 3.7 *Thorough Financial Analysis Results from the LM OTEC Business Plan Model*

The LM Team will develop ranges for the primary cost drivers for both the nearshore and the grazing OTEC systems of low (optimistic), medium (expected) and high (pessimistic) values. The primary cost driver for both systems is the capital cost of the OTEC plant for the nearshore system and the capital plant cost of the OTEC system and the energy carrier infrastructure for the grazing OTEC system. Thus, capital cost estimates will be developed for the three cases. Operations and Maintenance cost estimates will be developed to include low, medium and high cost considerations. Finally, the interest rates used to finance the nearshore and grazing OTEC system have a strong influence on the cost of the energy output from both of these systems. Ranges of possible interest rates will also be included in establishing the cost estimate ranges.

Development of OTEC Energy Supply Curves

Part two of the economic analysis focuses on developing Energy Supply Curves for both nearshore OTEC systems as well as grazing OTEC plants that produce an energy carrier for transport to the continental US.

Unlike most other sustainable energy sources, the energy resource for OTEC is nearly constant except for some seasonal variations in surface water temperature, depending on location. Other renewable energy sources such as solar, wind, wave, etc. are strongly dependent on the resource available at a particular location. Some locations are quite preferred while other locations may still be usable but are less desirable due to lower resource level.

Thus, a solar panel or wind turbine located at the preferred site produces the maximum energy output but the identical unit located at another site may produce less output power resulting in a higher energy production cost. This results in the typical positive slope Energy Source Curve as shown in Figure 3.8A where increasing energy output is achieved by using less desirable resource areas resulting in higher energy cost.

In the case of nearshore OTEC Plants providing electrical power directly to the grid, the energy resource for each plant is the same. Thus, for OTEC Plants with the same power output and the same capital cost and financing conditions, the Energy Supply Curve will be a flat line as shown in Figure 3.8B. If manufacturing efficiencies reduce the cost to build subsequent OTEC plants, then the Energy Curve will slope downward for these plants resulting in the green dotted line. Finally, larger scale OTEC Plants may substantially reduce the cost/KWh of produced energy resulting in Figure 3.8C Energy Supply Curve.

Again, the economies of scale for OTEC Plants help to reduce the Energy Supply Curve for increasing plant size, all other factors remaining unchanged.

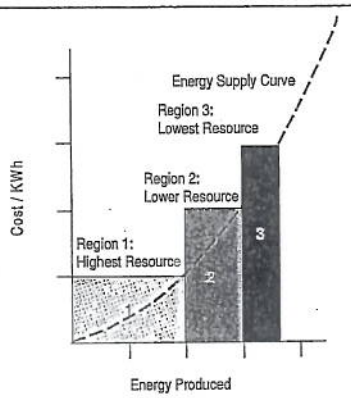


Figure 3.8A *Typical Shape of Solar or Wind Energy Supply Curves*

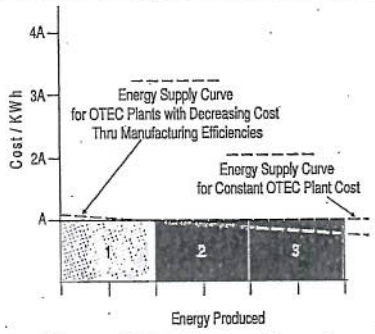


Figure 3.8B *Energy Supply Curves for Constant OTEC Plant Cost and Decreasing Plant Costs from Manufacturing Efficiencies*

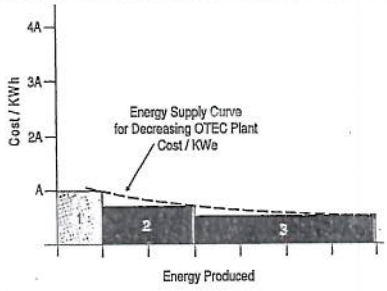


Figure 3.8C *Larger OTEC Plants Reduce the Output Cost/KWh Causing the Energy Supply Curve to Decrease*

For grazing OTEC plants operating within a narrow band near the Equator, the seasonal variations will be near zero so the energy will be virtually constant within this low latitude region of the world. The operational scenario for the mid ocean grazing OTEC plants is based upon the SBIR work performed by the Makai/LM for the Navy in 2008. Base-load electricity from OTEC generates the power for electrolyzers to separate hydrogen from potable water. Nitrogen from an air separation system is combined with the hydrogen to create ammonia. The cost estimate for the grazing OTEC system is strongly influenced by the cost of the electrolyzers and related elements of the ammonia production system. Thus, high, medium and low cost estimates for these elements will be used in the financial analysis.

The Energy Supply Curve for open ocean grazing OTEC Plants producing ammonia for transport to the US will look quite similar to the flat curve of Figure 3.8B. However, the further the OTEC Plants are from the entry port for the US, the higher will be the transportation costs for the energy carrier. Having looked into these costs under the SBIR Study in 2008, we expect that the increase in transportation due to increased distances will be a second order effect on the Energy Supply Curve. Figure 3.8D shows the notional shape of the Energy Supply Curve for the open ocean grazing OTEC plants. The substantial challenge in this task is to predict the total system capital cost including O&M costs for all phases of the operation and obtain values for the expected price of the fuel and the expected transportation cost as a function of distance.

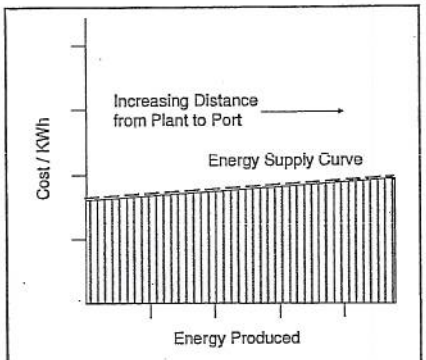


Figure 3.8D *Notional Energy Supply Curve for Open Ocean Grazing OTEC Plants*

Task 6 Products

- Financial analysis of nearshore OTEC Plant Cost of Electricity for high, medium, and low cost system cost estimates
- Financial analysis of open ocean grazing OTEC Plant cost of producing and delivering anhydrous ammonia to the continental US for high, medium, and low system cost estimates

- Energy Supply Curves showing high, medium and low estimates for cost of electricity for nearshore OTEC Plants operating under different scenarios
- Energy Supply Curves showing high, medium and low estimates for the cost of producing and delivering anhydrous ammonia to the continental US.

OTEC Life Cycle Cost Analysis Schedule of Tasks

The LM Team has developed a project schedule shown in Figure 3.9 for the OTEC Life Cycle Cost Analysis project that follows the WBS and achieves project objectives within the required time period.

4. Distribution of Results

The LM Team plans to make wide distribution of the results of the OTEC Life Cycle Cost Analysis using the Internet, presentations at conferences and trade shows, and articles in trade magazines.

Publicizing the results of the OTEC life Cycle Cost Analysis fits directly in with the LM Team's OTEC Information Outreach Program where we take every opportunity to educate the public regarding the features and benefits of OTEC as an element of the renewable energy mix for the US. We feel that in many ways OTEC is well behind most other renewable energy technologies in the minds of the public so a concerted education effort is needed. The results of this study, however, are highly technical and will be of interest to more technically knowledgeable decision-makers in DOE, other Federal agencies, possibly some coastal states and likely some foreign government and institutions. We will therefore publicize the results of this study in a manner that will reach the broadest possible technical audience.

A technical report of the study results will be published following a thorough review by the LM Team as well as by a selected group of knowledgeable advisors from industry, Government and academia. The report will contain useful information such as "rules of thumb" for quickly assessing the order of magnitude for a realistic Life Cycle Cost for an OTEC system based on gross plant costs and other useful types of non-proprietary information. Furthermore, the Energy Supply Curves will be useful for comparing the energy from OTEC systems with other renewable energy systems.

Internet Site

An Internet site is planed for use by the LM Team to publicize our progress on OTEC commercialization. A section of the web site will be dedicated to the OTEC Life Cycle Cost Analysis and a PDF copy of the Final Report will be available for downloading by interested individuals.

Presentations at Conferences and Trade Shows

The LM Team will develop a presentation based on the study Final Report for presentation at conferences such as the Ocean Energy Conference and the Offshore Technology Conference.

Publication in Trade Magazines

Focused articles on aspects of the OTEC Life Cycle Cost Analysis will be developed for publication in trade journals such as Sea Technology and Marine Reporter.

5. Qualifications and Resources

Management of the OTEC Life Cycle Cost Analysis Study

Lockheed Martin (LM) is the Prime Contractor for the OTEC Life Cycle Cost Analysis. LM has designated Robert Varley as the Program Manager responsible for managing the cost, technical and schedule aspects of the study and reporting to LM upper management. The Principal Investigator for this project is Richard Pavlosky, Senior Staff Project Engineer in the Global Sustainment organization with responsibilities for Life Cycle Cost analysis.

ID	WBS	Task Name
1	1	Technical Study Tasks
2	1.1	Near Shore Baseline
3	1.1.1	Evaluate/Qualify Available Data
4	1.1.2	Knowledge from Ongoing Efforts
5	1.1.3	Refine Notional Attributes
6	1.1.4	Develop Near Shore IDD
7	1.1.5	Near Shore IDD Complete
8	1.1.6	Calibrate DOWA model
9	1.1.7	DOWA Model Baseline
10	1.1.8	Task 1 Success Criteria Milestone
11	1.2	Offshore Baseline
12	1.2.1	Evaluate/Qualify Available Data
13	1.2.2	Knowledge from Ongoing Efforts
14	1.2.3	Refine Notional Attributes
15	1.2.4	Develop Offshore IDD
16	1.2.5	Offshore IDD Complete
17	1.2.6	Calibrate DOWA model
18	1.2.7	DOWA Model Baseline
19	1.3	Technology Development
20	1.3.1	Identify Technologies
21	1.3.2	Identify Cost Drivers
22	1.3.3	Identify Candidates for Improvement
23	1.4	Environmental Cost Assessment
24	1.4.1	Evaluate Start Up Environmental Costs
25	1.4.2	Evaluate Recurring Environmental Costs
26	1.4.3	Identify Economy of Scale
27	1.4.4	Establish Environmental Cost Model
28	1.5	Life Cycle Costs
29	1.5.1	Qualify Notional Near Shore Attributes
30	1.5.2	Qualify Notional Floating Attributes
31	1.5.3	O&M Configurations complete
32	1.5.4	Determine OTEC Cost Savings Configurations
33	1.5.5	Top Level LCE/TOC Analysis
34	1.5.6	Calibrate OTEC Cost Model
35	1.5.7	Integrate into Cost Model
36	1.5.8	Identify LCE Scenarios
37	1.6	OTEC Economics
38	1.6.1	Commercialization
39	1.6.2	Economies of Scale/Time
40	1.6.3	Update Economic Model
41	2	Program Management
42	2.1	System Engineering
45	2.2	Dissemination of Results
49	2.3	Meetings
55	2.4	Quartely Reporting

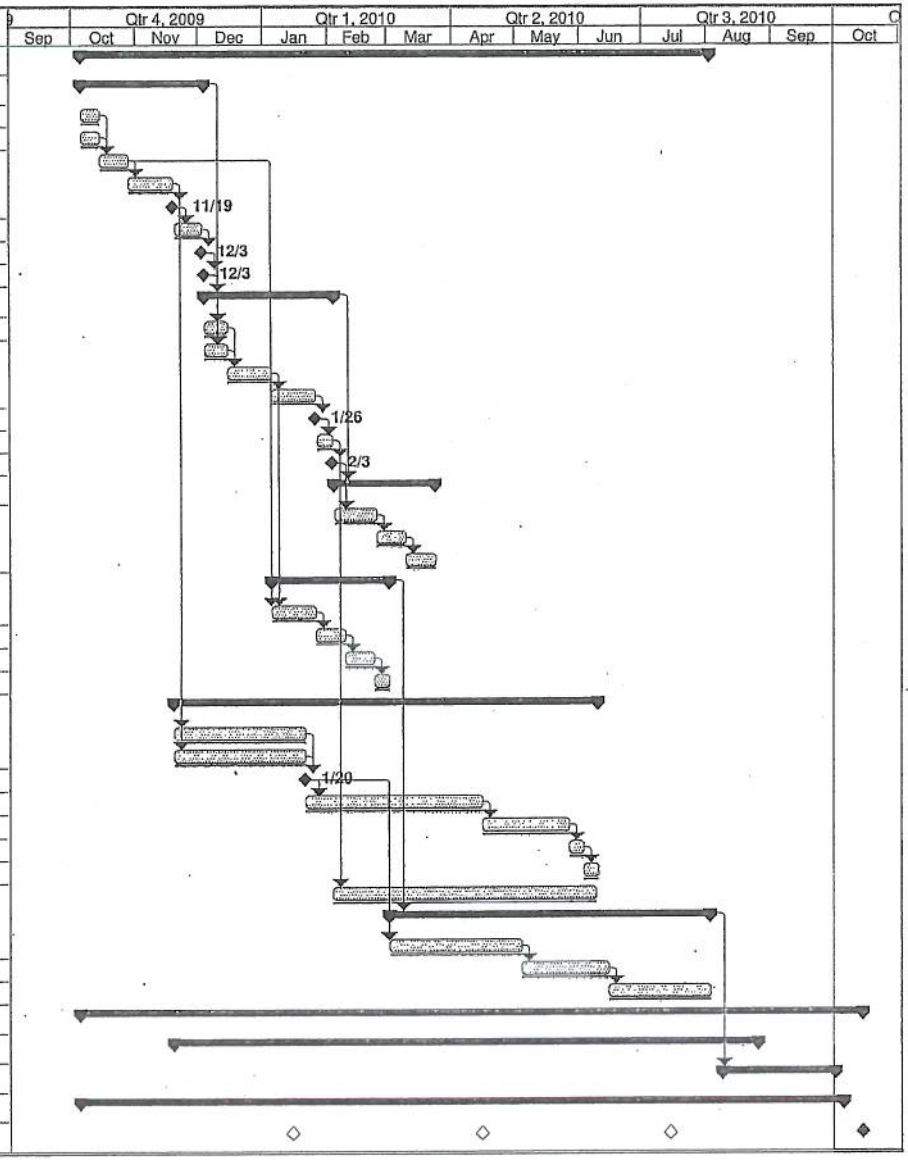


Figure 3.9 *Schedule for OTEC Life Cycle Cost Analysis Tasks and Activities*

LM has a recognized strength in exercising Systems Engineering discipline in all development programs from small studies to development of multi-billion dollar weapon systems. Applying the Systems Engineering discipline to the work under each technical task ensures traceability form Top Level Requirements (TLRs) to system specifications and then down to subsystem specifications. The process also ensures thorough and non-biased assessment of trade study. The identified products for each task will be evaluated and represent the go/no-go decision criteria for task completion.

Meetings with the DOE customer are scheduled and handled on a quarterly basis beginning with a Kick-off presentation and concluding with a Final Presentation.

The following paragraphs describe the credentials of the LM Team.

Lockheed Martin

As the largest defense contractor in the US, LM possesses skills in complex systems integration & engineering. We are experienced in identifying key technology areas for risk reduction, incorporating relationships with small business partners, and leveraging skills and capabilities across the LM Corporation. LM has both won grants and made internal investments to develop and refine critical OTEC technologies such as the cold water pipe and heat exchangers to reduce technical risk and overall costs.

LM's OTEC efforts started in 1974 when Lockheed began a "9-month study of the practicality of generating electrical power at competitive bus bar prices by using the solar energy that is stored as a thermal gradient in the world's oceans."

This study was followed with a self-funded demonstration called Mini-OTEC in 1979. Mini-OTEC was designed, constructed, deployed and then operated by the LM team for four months off the Big Island of Hawaii to gather technical data on the operation of the system. Mini-OTEC remains the only floating, net-power producing OTEC plant ever built.

LM is currently supporting several projects that will reconstitute the large scale testing capability at the Natural Energy Laboratory Hawaii Authority (NELHA) located on the Kona coast of the Big Island in Hawaii and is providing advanced heat exchanger materials for testing.

LM is applying its extensive expertise in Life Cycle Cost (LCC) Analysis to this proposed effort. Our staff has a wealth of analytical models for use in analyzing LCC of complex systems and years of experience with weapon systems such as the F-16 Fighter, the AEGIS Radar System, the modern Littoral Combat Ship, and numerous equipment types under various classified programs. This expertise will enable the LM team to accurately forecast the Operations and Maintenance needs for nearshore and grazing OTEC systems.

Makai Ocean Engineering

Makai is a small business located on Oahu in Hawaii that specializes in alternate ocean energy (OTEC and Seawater air conditioning) and software for submarine cable planning and installation control. In the past 29 years Makai has been involved in the analysis, design, construction, operation, and testing of 12 OTEC-related projects throughout the world. Makai was involved in the DOE/NOAA Cold Water Pipe program, OTEC-1, Mini-OTEC, the DOE 40MW OTEC design for Oahu, testing of Aluminum Heat Exchangers for DARPA, investigating Fabric Pipe designs for SERI, designing a 50KW OTEC demonstration plant (DARPA); and is currently designing and building an OTEC heat exchanger testing facility in Hawaii (NAVFAC, ONR). The Makai ONR-supported SBIR work in 2006-8 addressed the viability of OTEC to provide massive quantities of hydrogen or ammonia in a future world without oil. Lockheed Martin supported the SBIR with system engineering and business case development expertise. Makai has been a member of the LM OTEC design team for the past 2-1/2 years providing significant engineering support to all aspects of the Lockheed Martin IR&D funded design studies. Makai is part of the platform, OTEC arrangement, CWP, heat exchanger, thermal cycle, and cable design teams.

G. Noland & Associates, Inc.

GNA Inc is a small company of highly skilled individuals with experience in hydrogen energy systems, ammonia as an energy carrier, innovative OTEC design concepts, renewable energy systems, program management experience, and financial / power industry experience. GNA Inc supports both the OTEC project with technical contributions as well as strategy for business development.

Planning Solutions Inc.

Planning Solutions Inc. (PSI) is a small company located in Honolulu, Hawaii with expertise in the area of environmental compliance, impact assessments and associated Hawaiian regulations. PSI is leading the efforts to plan the approach for obtaining the necessary permits to site the OTEC plants off the coast of Oahu and to bring the electrical power cables to shore for grid connection. PSI drafted the Environmental Impact Statement (EIS) for the latest significant (100 MWe) electrical generating station on Oahu, and helped secure all the major land use permits for the facility, which is currently under construction for the Hawaiian Electric Company. PSI is currently working on several renewable energy projects in Hawaii, including wind and wave power as well as waste-to-energy and bio-diesel projects.

For the past two years PSI has worked on the LM Team to identify the environmental assessment and permitting requirements for developing OTEC systems in Hawai'i and has produced permitting analysis studies as well as proposed environmental study plans. PSI will take advantage of this experience and its established relationships with the LMCO team members to produce the best possible cost estimates for environmental analysis and permitting, efficiently and with a minimal learning curve.

John Halkyard & Associates, Inc.

John Halkyard & Associates is a small company based in Houston that is well recognized in the field of offshore platform design for the petroleum industry. The president, Dr. Halkyard, has many years of offshore platform experience and participated in the design of the original spar platforms that are highly stable and require less anchoring forces that other platform types.

Glosten Associates

Glosten Associates, Inc. is a naval architecture firm in Seattle WA recognized for innovative designs and support work for the offshore oil industry. The firm has specialized expertise in hydrodynamic analysis, consulting services and economic analysis, climatology and risk analysis to serve vessel operating clients and marine civil engineers and contractors.

LM Team Assets and Resources

- Leverage more than $10M of work with similar focus in recent and ongoing programs as a solid starting point to perform the required work under this study
- Complete Concept Design of 10 MWe Prototype and 100 MWe Commercial OTEC plants along with a thorough cost estimate in 2008 of both the 10MW and 100MW grid connected OTEC plants using a system-wide Work Breakdown Structure which consisted of 18 overall categories containing 325 summarized line items
- Makai SBIR reports defining an OTEC industry based on grazing open ocean OTEC producing anhydrous ammonia transported to terminals in the US for distribution
- OTEC cost and technical computer models applicable to both grid connected and offshore systems
- A well documented Business Plan for development and commercialization of OTEC with detailed financial analysis showing an attractive business opportunity, business implementation strategies, risks and mitigation approaches, overall conclusions and recommendations for LM Team management
- Practical assessment of technology and a detailed plan for quantifying know technical obstacles and applying new materials and methods to overcoming these obstacles
- Discussions with Hawaii Electric Company to develop a technical approach and business strategy to resolve OTEC/grid interface issues.

6. Cross Reference Matrix of FOA Requirements to Proposal Section

FOA Requirement	Description	Relevant Proposal Sections
1: Technical Merit and Innovation		
Ability of the project to help further industry-wide deployment and development	The LM team has been working on OTEC commercialization and costs for the past two and a half years, the largest and most focused effort underway in the US with significant progress.	2. Technical Merit and Innovation; Task 6: OTEC Economic Analysis
Degree to which the application addresses one or more of the research topics associated with this topic area	Capital and operational costs from ongoing designs will be extrapolated for this project, applied to Total Ownership Cost / Life Cycle Cost analysis to derive future O&M and life cycle cost. For each baseline, several scenarios will be evaluated to develop energy supply curves with high and low expectations.	Task 1: Near Shore Grid Connected Baseline; Task 2: Offshore OTEC Industry Producing an Energy Carrier Task 4: Environmental Cost Assessment; Task 5: OTEC Life Cycle Costs Analysis
Degree to which the project will improve upon the current state of knowledge related to the subtopic in question	This project will apply the most timely OTEC concepts and visions being developed today by an extensive team brainstorming OTEC for the past several years	Task 3: Technology Development Program and Costs; Potential Technology Evolution; Task 6: OTEC Economic Analysis
2: Technical Approach and Project Research Plan		
Viability of technical approach and the project research plan to achieve FOA objectives	Already an experienced team committed to OTEC development with the stated objective to achieve commercialization. We apply and extend our recent and ongoing technical and costing work to complete this project	1. Project Objectives
Degree to which proposed plan is clearly stated, organized, achievable and technically feasible	An integrated project schedule has been developed for the OTEC Life Cycle Cost Analysis project that follows the WBS and achieves the required results within the required time period.	Figure 3.10 Schedule for OTEC Life Cycle Cost Analysis All Tasks
Adequacy of the identification and assessment of critical success factors, risks and barriers, as well as plans for mitigating.	Systems Engineering to perform requirements development, risk analysis and assumptions tracking across each of the other seven technical tasks	Program Management and Systems Engineering
3: Qualifications & Resources		
Capabilities, experience and qualifications of team members.	This team has worked together on OTEC systems for the past few years; it includes both large and small businesses with a history of involvement in OTEC and expertise relevant to developing commercial OTEC Plants.	4. Qualifications and Resources
Availability of required equipment, laboratory and demonstration facilities, analytic support.	The team has existing computer programs for the technical analysis, sizing and costing of OTEC and the business development of OTEC.	2. Technical Merit and Innovation 4. Qualifications and Resources
Demonstrated support of each team member's participation	The LM Team members by continuing participation has demonstrated a high commitment to developing a commercial OTEC Plant.	see *Letters of Commitment* submitted with the proposal
4: Distribution of Results		
Comprehensiveness of plan to disseminate results to others in the water power industry	Our plan to disseminate the study results includes making the Final Report available on the Internet, making presentations at trade shows, publishing articles in trade magazines	Task 7: Distribution of Results

Figure 6.1 *We Achieve All the Research Objectes of Sub-topic Area 3C*

John Halkyard & Associates
14121 Cardinal Lane
Houston, TX 77079 USA
Ph. +1 281-556-0893
Fax +1-773-496-0893
JHalkyard@AOL.com

May 28, 2009

Mr. August Walker
Lockheed Martin Corporation
9500 Godwin Ave
Manassas, VA 20110-4157

Dear Mr. Walker,

John Halkyard and Associates is pleased to confirm its commitment as a participant with Lockheed Martin for Topic Area 3C application entitled "An assessment of projected like cycle costs for ocean thermal energy conversion in the United States over time."

Sincerely,

John Halkyard

John Halkyard, President

LINDA LINGLE
GOVERNOR
THEODORE E. LIU
DIRECTOR
MARK K. ANDERSON
DEPUTY DIRECTOR

DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM

No. 1 Capitol District Building, 250 South Hotel Street, 5th Floor, Honolulu, Hawaii 96813
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804
Web site: www.hawaii.gov/dbedt

Telephone: (808) 586-2355
Fax (808) 586-2377

June 1, 2009

Mr. Ted G. Johnson
Director, Alternative Energy Programs Development
Lockheed Martin
9500 Godwin Drive
M/S 400/046
Manassas, Virginia 20110

Dear Mr. Johnson:

I am writing to express support for the project proposed by Lockheed Martin in response to the U.S. Department of Energy's Funding Announcement DE-FOA-0000069 for Advanced Water Power. Your proposal addresses Topic 3C, a Proposed Life Cycle Cost Analysis of OTEC.

Surrounded by the Pacific Ocean, Hawaii is in a unique position to transform ocean energies into electricity. Our state's record of cutting-edge Ocean Thermal Energy Conversion research, some of it performed in partnership with Lockheed, and our critical need to reduce the use of imported fossil fuels makes this proposal an urgent one for Hawaii.

This proposal plans to leverage the large volume of work that Lockheed has already performed on OTEC to define and price a floating OTEC system as the baseline for a life cycle cost analysis. The eventual goal is to develop a commercial 100 MW OTEC plant for Hawaii. In addition, Lockheed's team has developed concepts and assessed the operational scenario of a fleet of OTEC plants grazing in equatorial waters providing sustainable fuels to the continental U.S.; this work was performed under SBIR studies funded by the U.S. Navy. This material, plus the recent Lockheed Martin OTEC team design and cost studies, will form the basis for developing life cycle costs and energy supply curves for this future industry.

Performing the research, development and demonstration necessary to bring OTEC to full commercial status is an important part of the Hawaii Clean Energy Initiative's bold, innovative, and comprehensive commitment to transform Hawaii's electricity and energy systems to be 70% powered by energy efficient and renewable energy technologies by 2030.

In October of 2008, Governor Lingle signed an Agreement with the Hawaiian Electric Companies to advance the implementation of renewable energy, increase energy efficiency, and improve grid operation and infrastructure. The deployment of OTEC plants was explicitly included in the Agreement. In addition, in November 2008 Governor Lingle facilitated an agreement between Lockheed Martin and the Industrial Technology Research Institute of Taiwan to explore the development of OTEC in Hawaii and in Taiwan.

Hawaii is an ideal location for ocean thermal energy conversion, with warm, tropical surface waters as well as cold, deep waters close to shore. OTEC promises to provide clean, renewable base load constant energy.

Hawaii projects and successes can serve as a model for the rest of the U.S. and for island areas around the world. I wish you success on this project.

Sincerely,

Theodore E. Liu

cc: Mital Gandhi, Lockheed Martin

MAKAI OCEAN ENGINEERING, INC.
P.O. BOX 1206 KAILUA, OAHU, HAWAII 96734 USA

June 1, 2009

A. M. Walker
Subcontracts and Procurement
Lockheed Martin Maritime Systems and Sensors

RE: RE: DE-FOA-0000069 – Support for Lockheed Martin's Advanced Water Power Proposal

Dear Mr. Walker,

Makai Ocean Engineering strongly supports the proposal submitted by Lockheed Martin to the U.S. Department of Energy for the Advanced Water Power funding opportunity DE-FOA 0000069 under Topic Area 3: An assessment of projected life-cycle costs for ocean thermal energy conversion in the United States over time.

If Lockheed Martin is successful in winning this award, Makai Ocean Engineering will be pleased to support them in this effort.

Sincerely,

Reb Bellinger

Reb Bellinger
Vice President

OCEAN ENGINEERING AND NAVAL ARCHITECTURAL SERVICES
LOCATED AT MAKAPUU POINT, OAHU, HAWAII
(808) 259-8871 • FAX (808) 259-8238
E-mail: makai@makai.com

Lockheed Martin Corporation
9500 Godwin Dr.
Manassas, VA 20110
Attn: August Walker

June 1, 2009

Subject: Commitment of Support to OTEC Life Cycle Cost Assessment

Dear Mr. Walker,

This letter confirms the commitment by G. Noland & Associates, Inc. to participate as a subcontractor to Lockheed Martin in **An Assessment of Projected Life Cycle Costs for Ocean Thermal Energy Conversion in the United States Over Time.**

Thank you for the opportunity to take part in this important effort.

Respectfully,

Gary Noland
President
G. Noland & Associates, Inc.

PLANNING SOLUTIONS

June 2, 2009

Mr. August Walker
Procurement Representative
Lockheed Martin Corporation
9500 Godwin Avenue
Manassas, VA 20110
Sent via Email: august.walker@lmco.com

Subject: Letter of Commitment, Lockheed Proposal to U.S. Department of Energy FOA - 0000069, Task 4 in Topic Area 3C

Dear Mr. Walker:

Planning Solutions, Inc. is pleased to confirm its commitment as a participant with Lockheed Martin for Topic Area 3C application entitled, "*An assessment of projected life-cycle costs for ocean thermal energy conversion in the United States over time.*".

Please call Dr. Charles Morgan or me at 550-4483 if you have any questions or would like additional information.

Sincerely,

Perry J. White, President,
Planning Solutions, Inc.

Ward Plaza, Suite 330 • 210 Ward Avenue • Honolulu, Hawaii 96814-4012
Phone: 808 550-4483 • Fax: 808 550-4549 • www.psi-hi.com

OMB Number: 4040-0004
Expiration Date: 01/31/2009

Application for Federal Assistance SF-424 Version 02

*1. Type of Submission:	*2. Type of Application	* If Revision, select appropriate letter(s)
☐ Preapplication	☒ New	
☒ Application	☐ Continuation	*Other (Specify)
☐ Changed/Corrected Application	☐ Revision	

*3. Date Received: 4. Applicant Identifier:

5a. Federal Entity Identifier:	*5b. Federal Award Identifier:

State Use Only:

6. Date Received by State:	7. State Application Identifier:

8. APPLICANT INFORMATION:

*a. Legal Name: Lockheed Martin Corporation

*b. Employer/Taxpayer Identification Number (EIN/TIN):	*c. Organizational DUNS:
521893632	019710586

d. Address:

*Street 1: 9500 Godwin Dr
Street 2:
*City: Manassas
County:
*State: VA
Province:
*Country: Prince William
*Zip / Postal Code 20110

e. Organizational Unit:

Department Name:	Division Name:
New Ventures	Maritime Systems and Sensors

f. Name and contact information of person to be contacted on matters involving this application:

Prefix: Mr *First Name: Stan
Middle Name:
*Last Name: Barasha
Suffix:

Title: Contracts Manager

Organizational Affiliation:	
*Telephone Number: 703 367 5377	Fax Number: 703 367 2385
*Email: stan.barasha@lmco.com	

OMB Number: 4040-0004
Expiration Date: 01/31/2009

Application for Federal Assistance SF-424 Version 02

9. Type of Applicant 1: Select Applicant Type:
Q. For-profit Org(Other Than Small Business)

Type of Applicant 2: Select Applicant Type:

Type of Applicant 3: Select Applicant Type:

*Other (Specify)

***10 Name of Federal Agency:**
Department of Energy - Golden Field Office

11. Catalog of Federal Domestic Assistance Number:

81.087

CFDA Title:

***12 Funding Opportunity Number:**

DE-FOA-0000069 3C

*Title:
Advanced Water Power

13. Competition Identification Number:

Title:

14. Areas Affected by Project (Cities, Counties, States, etc.):

*15. Descriptive Title of Applicant's Project:

OTEC Life Cycle Cost Analysis

OMB Number: 4040-0004
Expiration Date: 01/31/2009

Application for Federal Assistance SF-424 Version 02

16. Congressional Districts Of:

*a. Applicant: VA-010 *b. Program/Project: VA-010,HI-001;HI-002,TX-007,CA-011

Attach an additional list of Program/Project Congressional Districts if needed.

17. Proposed Project:

*a. Start Date: Oct 1, 2009 *b. End Date: Sep 30, 2010

18. Estimated Funding ($):

*a. Federal	499,701
*b. Applicant	0
*c. State	0
*d. Local	0
*e. Other	0
*f. Program Income	0
*g. TOTAL	499,701

*19. Is Application Subject to Review By State Under Executive Order 12372 Process?

☐ a. This application was made available to the State under the Executive Order 12372 Process for review on _____

☐ b. Program is subject to E.O. 12372 but has not been selected by the State for review.

☒ c. Program is not covered by E. O. 12372

*20. Is the Applicant Delinquent On Any Federal Debt? (If "Yes", provide explanation.)

☐ Yes ☒ No Explanation:

21. *By signing this application, I certify (1) to the statements contained in the list of certifications** and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances** and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U. S. Code, Title 218, Section 1001)

☒ ** I AGREE

** The list of certifications and assurances, or an internet site where you may obtain this list, is contained in the announcement or agency specific instructions

Authorized Representative:

Prefix: Mr. *First Name: Stan

Middle Name:

*Last Name: Barasha Suffix:	
*Title: Contracts Manager	
*Telephone Number: 703 367 5377	Fax Number: 703 367 2385
* Email: stan.barasha@lmco.com	
*Signature of Authorized Representative:	*Date Signed: 6/3/09

Authorized for Local Reproduction

Standard Form 424 (Revised 10/2005)
Prescribed by OMB Circular A-102

OMB Number: 4040-0004
Expiration Date: 01/31/2009

Application for Federal Assistance SF-424 Version 02

*Applicant Federal Debt Delinquency Explanation

The following should contain an explanation if the Applicant organization is delinquent of any Federal Debt.

N/A

CERTIFICATIONS AND ASSURANCES

For Use with
SF 424, Block 21
SF 424 (R&R), Block 18
SF 424 Mandatory, Block 17
SF 424 Individual, Block 7

PART 1. GOVERNMENT-WIDE CERTIFICATION

A. Certification Regarding Lobbying Restrictions in 31 U.S.C. 1352

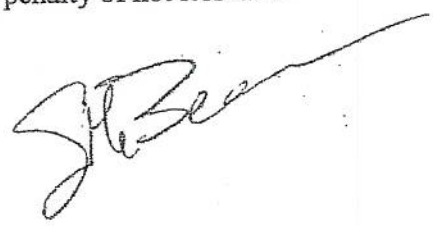
I certify, to the best of my knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the applicant, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the Federal contract, grant, loan, or cooperative agreement, the applicant shall complete and submit Standard Form - LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The applicant shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance will be placed when entering into any transaction made or entered into as a result of this application. Submission of this certification is a prerequisite for making or entering into a transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certificate shall be subject to a civil penalty of not less than $10,000, and not more than $100,000 for each such failure.



PART 2. DOE-SPECIFIC ASSURANCES

ATTACHMENTS

A. NATIONAL POLICY ASSURANCES TO BE INCORPORATED AS AWARD TERMS

B. DOE F 1600.5 Assurance of Compliance – Nondiscrimination in Federally Assisted Programs

DOE F 1600.5

(06-94)

All Other Editions are Obsolete

U.S. Department of Energy

Assurance of Compliance

OMB Control No. 1910-0400

Nondiscrimination in Federally Assisted Programs

OMB Burden Disclosure Statement

Public reporting burden for this collection of information is estimated to average 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Office of Information Resources Management Policy, Plans, and Oversight, Records Management Division, HR-422 - GTN, Paperwork Reduction Project (1900-0400), U.S. Department of Energy, 1000 Independence Avenue, S.W., Washington, DC 20585; and to the Office of Management and Budget (OMB), Paperwork Reduction Project (1900-0400), Washington, DC 20503.

The Applicant hereby AGREES to comply with Title VI of the Civil Rights Act of 1964 (Pub. L.88-352), Section 16 of the Federal Energy Administration Act of 1974 (Pub.L.93-275), Section 401 of the Energy Reorganization Act of 1974 (Pub.L.93-438), Title IX of the Education Amendments of 1972, as amended (Pub.L.92-318, Pub.L.93-568, and Pub.L.94-482), Section 504 of the Rehabilitation Act of 1973 (Pub.L.93-112), the Age Discrimination Act of 1975 (Pub.L.94-135), Title VIII of the Civil Rights Act of 1968 (Pub.L.90-284), the Department of Energy Organization Act of 1977 (Pub.L.95-91), and the Energy Conservation and Production Act of 1976, as amended (Pub.L.94-385) and Title 10, Code of Federal Regulations, Part 1040. In accordance with the above laws and regulations issued pursuant thereto, the Applicant agrees to assure that no person in the United States shall, on the ground of race, color, national origin, sex, age, or disability, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity in which the Applicant receives Federal assistance from the Department of Energy.

Applicability and Period of Obligation

In the case of any service, financial aid, covered employment, equipment, property, or structure provided, leased, or improved with Federal assistance extended to the Applicant by the Department of Energy, this assurance obligates the Applicant for the period during which Federal assistance is extended. In the case of any transfer of such service, financial aid, equipment, property, or structure, this assurance obligates the transferee for the period during which Federal assistance is extended. If any personal property is so provided, this assurance obligates the Applicant for the period during which it retains ownership or possession of the property. In all other cases, this assurance obligates the Applicant for the period during which the Federal assistance is extended to the Applicant by the Department of Energy.

Employment Practices

Where a primary objective of the Federal assistance is to provide employment or where the Applicant's employment practices affect the delivery of services in programs or activities resulting from Federal assistance extended by the Department, the Applicant agrees not to discriminate on the ground of race, color, national origin, sex, age, or disability, in its employment practices. Such employment practices may include, but are not limited to, recruitment advertising, hiring, layoff or termination, promotion, demotion, transfer, rates of pay, training and participation in upward mobility programs; or other forms of compensation and use of facilities.

Subrecipient Assurance

The Applicant shall require any individual, organization, or other entity with whom it subcontracts, subgrants, or subleases for the purpose of providing any service, financial aid, equipment, property, or structure to comply with laws cited above. To this end, the subrecipient shall be required to sign a written assurance form, however, the obligation or both recipient and subrecipient to ensure compliance is not relieved by the collection or submission of written assurance forms.

Data Collection and Access to Records

The Applicant agrees to compile and maintain information pertaining to programs or activities developed as a result of the

Applicant's receipt of Federal assistance from the Department of Energy. Such information shall include, but is not limited to, the following: (1) the manner in which services are or will be provided and related data necessary for determining whether any persons are or will be denied such services on the basis of prohibited discrimination; (2) the population eligible to be served by race, color, national origin, sex, age, and disability; (3) data regarding covered employment including use or planned use of bilingual public contact employees serving beneficiaries of the program where necessary to permit effective participation by beneficiaries unable to speak or understand English; (4) the location of existing or proposed facilities connected with the program and related information adequate for determining whether the location has or will have the effect of unnecessarily denying access to any person on the basis of prohibited discrimination; (5) the present or proposed membership by race, color, national origin, sex, age, and disability, in any planning or advisory body which is an integral part of the program; and (6) any additional written data determined by the Department of Energy to be relevant to its obligation to assure compliance by recipients with laws cited in the first paragraph of this assurance.

The Applicant agrees to submit requested data to the Department of Energy regarding programs and activities developed by the Applicant from the use of Federal assistance funds extended by the Department of Energy, Facilities of the Applicant (including the physical plants, building, or other structures) and all records, books, accounts, and other sources of information pertinent to the Applicant's compliance with the civil rights laws shall be made available for inspection during normal business hours on request of an officer or employee of the Department of Energy specifically authorized to make such inspections. Instructions in this regard will be provided by the Director, Office of Civil Rights, U.S. Department of Energy.

This assurance is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts (excluding procurement contracts), property, discounts or other Federal assistance extended after the date hereto, to the Applicants by the Department of Energy, including installment payments on account after such data of application for Federal assistance which are approved before such date. The Applicant recognizes and agrees that such Federal assistance will be extended in reliance upon the representation and agreements made in this assurance and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant, the successors, transferees, and assignees, as well as the person(s) whose signature appears below and who are authorized to sign this assurance on behalf of the Applicant.

Applicant Certification

The Applicant certifies that it has complied, or that, within 90 days of the date of the grant, it will comply with all applicable requirements of 10 C.F.R. § 1040.5 (a copy will be furnished to the Applicant upon written request to DOE).

August 2005

U.S. DEPARTMENT OF ENERGY

FINANCIAL ASSISTANCE CERTIFICATIONS AND ASSURANCES FOR USE WITH SF 424

Applicant: Lockheed Martin MS2

Solicitation No.: DE-FOA-0000069

The following certifications and assurances must be completed and submitted with each application for financial assistance. The name of the person responsible for making the certifications and assurances must be typed in the signature block on the forms.

Certifications Regarding Lobbying; Debarment, Suspension and Other Responsibility Matters; and Drug Free Workplace Requirements

DOE F 1600.5, Assurance of Compliance Nondiscrimination in Federally Assisted Programs

CERTIFICATIONS REGARDING LOBBYING; DEBARMENT, SUSPENSION AND OTHER RESPONSIBILITY MATTERS; AND DRUG FREE WORKPLACE REQUIREMENTS

Applicants should refer to the regulations cited below to determine the certification to which they are required to attest. Applicants should also review the instructions for certification included in the regulations before completing this form. Signature of this form provides for compliance with certification requirements under 10 CFR Part 601 "New Restrictions on Lobbying," 10 CFR Part 606 "Governmentwide Debarment and Suspension (Nonprocurement) and 10 CFR Part 607 "Governmentwide Requirements for Drug-Free Workplace (Grants)." The certifications shall be treated as a material representation of fact upon which reliance will be placed when the Department of Energy determines to award the covered transaction, grant, or cooperative agreement.

1. LOBBYING

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

2. ADDITIONAL LOBBYING REPRESENTATION

Applicant organizations which are described in section 501(c)(4) of the Internal Revenue Code of 1986 and engage in lobbying activities after December 31, 1995, are not eligible for the receipt of Federal funds constituting an award, grant, or loan.

As set forth in section 3 of the Lobbying Disclosure Act of 1995 as amended, (2 U.S.C. 1602), lobbying activities are defined broadly to include, among other thins, contacts on behalf of an organization with specified employees of the Executive Branch and Congress with regard to Federal legislative, regulatory, and program administrative matters.

Check the appropriate block:

The applicant is an organization described in section 501(c)(4) of the Internal Revenue Code of 1986? ☐ Yes ☒ No

If you checked "Yes" above, check the appropriate block:

The applicant represents that after December 31, 1995 it ☐ has ☐ has not engaged in any lobbying activities as defined in the Lobbying Disclosure Act of 1995, as amended.

3. DEBARMENT, SUSPENSION, AND OTHER RESPONSIBILITY MATTERS

(1) The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

(b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust

statutes or commission of embezzlement, theft, forgery, bribery; falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and

(d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

(2) Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

4. DRUG-FREE WORKPLACE

This certification is required by the Drug-Free Workplace Act of 1988 (Pub.L. 100-690, Title V, Subtitle D) and is implemented through additions to the Debarment and Suspension regulations, published in the Federal Register on January 31, 1989, and May 25, 1990.

ALTERNATE I (GRANTEES OTHER THAN INDIVIDUALS)

(1) The grantee certifies that it will or will continue to provide a drug-free workplace by:

(a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;

(b) Establishing an ongoing drug-free awareness program to inform employees about:

(1) The dangers of drug abuse in the workplace;
(2) The grantee's policy of maintaining a drug-free workplace;
(3) Any available drug counseling, rehabilitation, and employee assistance programs; and
(4) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace;

(c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);

(d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will:

(1) Abide by the terms of the statement; and
(2) Notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace not later than five calendar days after such conviction;

(e) Notifying the agency, in writing, within ten calendar days after receiving notice under subparagraph (d)(2) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to every grant officer or other designee on whose grant activity the convicted employee was working, unless the Federal agency has designated a central point for the receipt of such notices. Notice shall include the identification number(s) of each affected grant;

(f) Taking one of the following actions, within 30 calendar days of receiving notice under subparagraph (d)(2), with respect to any employee who is so convicted:

(1) Taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of the Rehabilitation Act of 1973, as amended; or
(2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State or local health, law enforcement, or other appropriate agency;

(g) Making a good faith effort to continue to maintain a drug- free workplace through implementation of paragraphs (a),(b),(c),(d),(e), and (f).

(2) The grantee may insert in the space provided below the site(s) for the performance of work done in connection with the specific grant:

Place of Performance: (Street address, city, county, state, zip code)

9500 Godwin Drive
Prince William County
Manassas, Va. 20110

☐ Check if there are workplaces on file that are not identified here.

ALTERNATE II (GRANTEES WHO ARE INDIVIDUALS)

(1) The grantee certifies that, as a condition of the grant, he or she will not engage in the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance in conducting any activity with the grant.

(2) If convicted of a criminal drug offense resulting from a violation occurring during the conduct of any grant activity, he or she will report the conviction, in writing, within 10 calendar days of the conviction, to every grant officer or other designee, unless the Federal agency designates a central point for the receipt of such notices. When notice is made to such a central point, it shall include the identification number(s) of each affected grant.

5. SIGNATURE

As the duly authorized representative of the applicant, I hereby certify that the applicant will comply with the above certifications.

Name of Applicant: **Lockheed Martin MS2**

Printed Name and Title of
Authorized Representative: **Stan Barasha, Contract Manager**

SIGNATURE

6/3/09
DATE

DOE F 1600.5
(06-94)
All Other Editions are Obsolete

U.S. Department of Energy

Assurance of Compliance

Nondiscrimination in Federally Assisted Programs

OMB Control No.
1910-0400

OMB Burden Disclosure Statement

Public reporting burden for this collection of information is estimated to average 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Office of Information Resources Management Policy, Plans, and Oversight, Records Management Division, HR-422 - GTN, Paperwork Reduction Project (1900-0400), U.S. Department of Energy, 1000 Independence Avenue, S.W., Washington, DC 20585; and to the Office of Management and Budget (OMB), Paperwork Reduction Project (1900-0400), Washington, DC 20503.

Lockheed Martin MS 2 (Hereinafter called the "Applicant")

HEREBY AGREES to comply with Title VI of the Civil Rights Act of 1964 (Pub. L.88-352), Section 16 of the Federal Energy Administration Act of 1974 (Pub.L.93-275), Section 401 of the Energy Reorganization Act of 1974 (Pub.L.93-438), Title IX of the Education Amendments of 1972, as amended (Pub.L.92-318, Pub.L.93-568, and Pub.L.94-482), Section 504 of the Rehabilitation Act of 1973 (Pub.L.93-112), the Age Discrimination Act of 1975 (Pub.L.94-135), Title VIII of the Civil Rights Act of 1968 (Pub.L.90-284), the Department of Energy Organization Act of 1977 (Pub.L.95-91), and the Energy Conservation and Production Act of 1976, as amended (Pub.L.94-385) and Title 10, Code of Federal Regulations, Part 1040. In accordance with the above laws and regulations issued pursuant thereto, the Applicant agrees to assure that no person in the United States shall, on the ground of race, color, national origin, sex, age, or disability, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity in which the Applicant receives Federal assistance from the Department of Energy.

Applicability and Period of Obligation

In the case of any service, financial aid, covered employment, equipment, property, or structure provided, leased, or improved with Federal assistance extended to the Applicant by the Department of Energy, this assurance obligates the Applicant for the period during which Federal assistance is extended. In the case of any transfer of such service, financial aid, equipment, property, or structure, this assurance obligates the transferee for the period during which Federal assistance is extended. If any personal property is so provided, this assurance obligates the Applicant for the period during which it retains ownership or possession of the property. In all other cases, this assurance obligates the Applicant for the period during which the Federal assistance is extended to the Applicant by the Department of Energy.

Employment Practices

Where a primary objective of the Federal assistance is to provide employment or where the Applicant's employment practices affect the delivery of services in programs or activities resulting from Federal assistance extended by the Department, the Applicant agrees not to discriminate on the ground of race, color, national origin, sex, age, or disability, in its employment practices. Such employment practices may include, but are not limited to, recruitment advertising, hiring, layoff or termination, promotion, demotion, transfer, rates of pay, training and participation in upward mobility programs; or other forms of compensation and use of facilities.

Subrecipient Assurance

The Applicant shall require any individual, organization, or other entity with whom it subcontracts, subgrants, or subleases for the purpose of providing any service, financial aid, equipment, property, or structure to comply with laws cited above. To this end, the subrecipient shall be required to sign a written assurance form, however, the obligation or both recipient and subrecipient to ensure compliance is not relieved by the collection or submission of written assurance forms.

Data Collection and Access to Records

The Applicant agrees to compile and maintain information pertaining to programs or activities developed as a result of the Applicant's receipt of Federal assistance from the Department of Energy. Such information shall include, but is not limited to, the following: (1) the manner in which services are or will be provided and related data necessary for determining whether any persons are or will be denied such services on the basis of prohibited discrimination; (2) the population eligible to be served by race, color, national origin, sex, age, and disability; (3) data regarding covered employment including use or planned use of bilingual public contact employees serving beneficiaries of the program where necessary to permit effective participation by beneficiaries unable to speak or understand English; (4) the location of existing or proposed facilities connected with the program and related information adequate for determining whether the location has or will have the effect of unnecessarily denying access to any person on the basis of prohibited discrimination; (5) the present or proposed membership by race, color, national origin, sex, age, and disability, in any planning or advisory body which is an integral part of the program; and (6) any additional written data determined by the Department of Energy to be relevant to its obligation to assure compliance by recipients with laws cited in the first paragraph of this assurance.

DOE F 1600.5
(06-94)
All Other Editions are Obsolete

OMB Control No.
1910-0400

The Applicant agrees to submit requested data to the Department of Energy regarding programs and activities developed by the Applicant from the use of Federal assistance funds extended by the Department of Energy, Facilities of the Applicant (including the physical plants, building, or other structures) and all records, books, accounts, and other sources of information pertinent to the Applicant's compliance with the civil rights laws shall be made available for inspection during normal business hours on request of an officer or employee of the Department of Energy specifically authorized to make such inspections. Instructions in this regard will be provided by the Director, Office of Civil Rights, U.S. Department of Energy.

This assurance is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts (excluding procurement contracts), property, discounts or other Federal assistance extended after the date hereto, to the Applicants by the Department of Energy, including installment payments on account after such data of application for Federal assistance which are approved before such date. The Applicant recognizes and agrees that such Federal assistance will be extended in reliance upon the representation and agreements made in this assurance and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant, the successors, transferees, and assignees, as well as the person(s) whose signature appears below and who are authorized to sign this assurance on behalf of the Applicant.

Applicant Certification

The Applicant certifies that it has complied, or that, within 90 days of the date of the grant, it will comply with all applicable requirements of 10 C.F.R. § 1040.5 (a copy will be furnished to the Applicant upon written request to DOE).

Designated Responsible Employee

STAN BARASHA, CONTRACT MGR
Name and Title (Printed to Typed)

(703) 367-5377
Telephone Number

Signature

6/3/09
Date

LOCKHEED MARTIN MS 2
Applicant's Name

(703) 367-5377
Telephone Number

9500 GODWIN DRIVE
Address:

6/3/09
Date

MANASSAS, VA. 20110

Authorized Official:
President, Chief Executive Officer
or ~~Authorized Designee~~

STAN BARASHA, CONTRACT MGR
Name and Title (Printed to Typed)

(703) 367-5377
Telephone Number

Signature

6/3/09
Date

DISCLOSURE OF LOBBYING ACTIVITIES

Approved by OMB
0348-0046

Complete this form to disclose lobbying activities pursuant to 31 U.S.C. 1352
(See reverse for public burden disclosure.)

1. Type of Federal Action:	2. Status of Federal Action:	3. Report Type:
[b] a. contract b. grant c. cooperative agreement d. loan e. loan guarantee f. loan insurance	[a] a. bid/offer/application b. initial award c. post-award	[a] a. initial filing b. material change **For Material Change Only:** year _____ quarter _____ date of last report _____

4. Name and Address of Reporting Entity:	5. If Reporting Entity in No. 4 is a Subawardee, Enter Name and Address of Prime:
[x] Prime [ ] Subawardee Tier _____, *if known*: LOCKHEED MARTIN MS2 9500 GODWIN DRIVE MANASSAS, VA 22551 **Congressional District**, *if known*: 4c VA010	N/A **Congressional District**, *if known*:
6. Federal Department/Agency: Department of Energy, Golden Field Office	**7. Federal Program Name/Description:** DE-FOA-0000069 CFDA Number, *if applicable*: 81.087
8. Federal Action Number, *if known*:	**9. Award Amount**, *if known*: $
10. a. Name and Address of Lobbying Registrant (*if individual, last name, first name, MI*): N/A	**b. Individuals Performing Services** (*including address if different from No. 10a*) (*last name, first name, MI*): N/A
11. Information requested through this form is authorized by title 31 U.S.C. section 1352. This disclosure of lobbying activities is a material representation of fact upon which reliance was placed by the tier above when this transaction was made or entered into. This disclosure is required pursuant to 31 U.S.C. 1352. This information will be available for public inspection. Any person who fails to file the required disclosure shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.	Signature: [signature] Print Name: Stan Barasha Title: Contract Manager Telephone No.: 703 367 5377 Date: 6/3/09
Federal Use Only:	Authorized for Local Reproduction Standard Form LLL (Rev. 7-97)

PLEASE NOTE THERE ARE NO DISCLOSED LOBBYING ACTIVITIES FOR DE-FOA-0000069.

OMB Number: 4040-0010
Expiration Date: 08/31/2011

Project/Performance Site Location(s)

Indicate the primary site where the work will be performed. If a portion of the project will be performed at any other site(s), identify the site location(s) in the blocks provided. You can copy the informational table as many times as needed, or delete tables that are not needed.

Note that the Project/Performance Site Congressional District is entered in the format of the 2 digit state code followed by a dash and a 3 digit Congressional district code, for example VA-001.

Project/Performance Site Location: Lockheed Martin MS2

Organization Name:	Lockheed Martin		
DUNS Number:	019710586		
*Street1:	9500 Godwin Drive		
Street2:			
*City:	Manassas	County:	Prince William
*State:	Virginia		
Province:			
*Country:	USA		
ZIP / Postal Code:	20110	Project / Performance Site Congressional District:	VA-010

Project/Performance Site Location: Makai Research Pier

Organization Name:	Makai Ocean Engineering, Inc.		
DUNS Number:	66-271768		
*Street1:	41-305 Kalanianaole Hwy.		
Street2:			
*City:	Waimanalo	County:	Honolulu
*State:	Hawaii		
Province:			
*Country:	USA		
ZIP / Postal Code:	96795	Project / Performance Site Congressional District:	HI-002

Project/Performance Site Location: Planning Solutions, Inc.

Organization Name:	Planning Solutions, Inc.		
DUNS Number:	947028049		
*Street1:	210 Ward Avenue		
Street2:	Suite 330		
*City:	Honolulu	County:	Honolulu
*State:	Hawaii		
Province:			
*Country:	USA		
ZIP / Postal Code:	96814	Project / Performance Site Congressional District:	HI-001

OMB Number: 4040-0010
Expiration Date: 08/31/2011

Project/Performance Site Location: John Halkyard and Associates
Organization Name: John Halkyard and Associates
DUNS Number:
*Street1: 14121 Cardinal Lane
Street2:
*City: Houston County: Harris
*State: Texas
Province:
*Country: USA
ZIP / Postal Code: 77079 Project / Performance Site Congressional District: TX-007

Project/Performance Site Location: Gary Noland and Associates
Organization Name: Gary Noland and Associates
DUNS Number:
*Street1: 3588 Touriga Drive
Street2:
*City: Pleasanton County: Alameda
*State: California
Province:
*Country: USA
ZIP / Postal Code: 94566 Project / Performance Site Congressional District: CA-011

RICHARD PAVLOSKY

Occupation	**Project Engineer Senior Staff**
Experience	2001 – Present, Lockheed Martin, Project Engineer, Global Sustainment 1992 – 2001, Lockheed Martin, Functional Manager
Education	Introduction to Performance Based Logistics (LS101), Lockheed Martin, 2009 Designing for Sustainment (LS207), Lockheed Martin, 2009 MS2 Earned Value Management (EVM) Training, Lockheed Martin, 2008 Real Time Project Training, Lockheed Martin, 2007 Process Improvement Program, Lockheed Martin, 2000 Defect Prevention Process (DPP), Lockheed Martin, 1992
Licensing / Certifications	
Memberships	

RELEVANT WORK EXPERIENCE

Prior to commencing a career with IBM/Loral/Lockheed Marin, served six years in the United States Navy as submarine service as a Data Systems Technician, where he began to develop his technical skills and leadership abilities. Currently, Rick has 26 years of experience in Field Engineering, Product Engineering, Team Leadership, and Department Management. In his current position, Rick manages diverse teams of highly skilled professionals including subcontractors, and is the primary programmatic and technical interface to customers and his team.

Rick is currently the Lockheed Martin Global Sustainment Lead at the Maritime Systems and Sensors (MS2) facility located in Manassas, VA. He has worked in the Global Sustainment organization for the past eight years. In this role, he performs as the direct customer interface point of contact for all logistics and sustainment efforts in support of submarine acoustic systems for four (4) different submarine classes on over seventy different platforms. He is directly responsible for the coordination, planning, and execution of all logistics elements across these platforms, ensuring fleet support is provided throughout the technical insertion process, as well as follow-on software updates. He monitors overall performance through direct interface with the customer and through the tracking of contract performance metrics such as Earned Value Management. Specific accomplishments include:

- Recognized for leadership and management skills by receiving a team Special Recognition Award in 2009 for overall superior performance based on direct customer feedback in the FY09 1st Quarter Informal Performance Assessment Report (IPAR)
- Supervises a team of more than twenty (20) personnel responsible for all facets of training, technical documentation, commercial off the shelf (COTS) equipment management, supportability engineering, field engineering services, and supply support for the ARCI Program

- Responsible for the integration of all design elements for logistics for the submarine acoustic sensor suite upgrades on all platforms
- Manages an annual budget of ~$12M for the logistics engineering services contract for the Acoustic Rapid Capability Insertion (ARCI) Program.
- Direct the collaborative performance of all team members ensuring contractual compliance, collaborative teaming approaches, and Integrated Product Team (IPT) adherence
- Responsible for the development and validation of cost proposals and estimates adhering to customer requirements

Rick also has experience as a Functional First Level Manager for the Test Engineering department, where his functional organization was responsible for the design and manufacturing of custom, large-scale, application-specific test equipment required to support on-site Lockheed Martin Manassas personnel and Navy System and Space programs.

In addition, he has performed as a Functional First Line Manager for the Data Management department. In this role, he was functionally responsible for up to twelve personnel involved in all aspects of contract data and document processing, management, and archival for Lockheed Martin Manassas programs.

He has also served as the Manager of the Network Support and Installation department. This department supported the Defense Messaging System (DMS) program. Rick served as the Lockheed Martin coordinator for development lab maintenance, establishment of the DMS Help Desk and processes. He also coordinated of the Lockheed Martin DMS subcontract team (Boeing, GE, Anstec, Andrulis, and CACI) assigned to Site Surveys and Installations. As this was a new market for Lockheed Martin, he was responsible for the conceptual development and implementation of new processes and procedures used on this program.

ROBERT VARLEY

Occupation	**Program Manager**
Experience	1997-Present Lockheed Martin Maritime Systems & Sensors 1984–1997 Naval Undersea Warfare Center Division Newport 1982-1984 MAR, Incorporated 1980-1981 US Coast Guard Research & Development Center 1974-1978 General Dynamics, Electric Boat Division
Education	Florida Institute of Technology, Ocean Engineering, BS, 1974 University of Rhode Island, Ocean Engineering, MS, 1985 Virginia Polytechnic Institute and State University, MBA, 2001
Licensing / Certifications	IEEE
Memberships	Oceanic Engineering Society, Power & Energy Society

RELEVANT WORK EXPERIENCE

Robert Varley has over thirty-five years of mechanical engineering disciplines.

Recently, Robert is the Program Manager that has managed projects and conduct business pursuit activities for sonar sensors and ship systems in the defense industry. Currently serves as Capture Manager to develop the division's ocean thermal energy business. Managed program cost/schedule/technical performance either as program manager or senior engineer for the High Frequency Chin Array, Light Weight Wide Aperture Array, AN/BQG-5A WAA programs. Developed and executed broad strategy to maintain core sonar sensor business and capture new responsibilities in Navy sonar and undersea weapon market areas.

As a Mechanical Engineer with Naval Undersea Warfare Center Division Newport, Robert developed ONR investment strategies, objectives, and project plans in Undersea Surveillance; promoted and coordinated transition opportunities to SYSCOM and PEO programs; technically analyzed projects and prepared documentation for ONR, OPNAV, DoD laboratories, OSD, and Congress; Managed multi-million dollar budgets and Navy/Contractor activities for SALFAS, TB-29, and TB-16 projects and tasks spanning 6.2 R&D through 6.4 engineering development.

At MAR, Incorporated, Robert evaluated submarine simulator target hydrodynamics; developed an R&D towed array beam former user's manual; piloted/supported airboat platform for towed array tests; designed test fixtures for USCG R&D Center synthetic line test facility

As an Ocean Engineer with the US Coast Guard Research & Development Center, Robert conducted Master's thesis research; designed & fabricated test fixtures the Coast Guard Academy Circulating Water Channel to measure synthetic line drag coefficients.

Robert worked as a Mechanical Engineer with General Dynamics, Electric Boat Division and coordinated design, construction, test, and qualification of TRIDENT submarine 3,000 GPD vapor compression distilling plant and demineralizers; supported new technology program to use electrodialysis to de-salt water.

Joseph Van Ryzin

Occupation	**Senior Ocean Engineer**
Experience	1973 - Present: Makai Ocean Engineering
Education	Ph.D. Ocean Engineering, University of Rhode Island, 1977 M.S. Mechanical Engineering, University of Rhode Island, 1968 B.S. Mechanical Engineering major, Electrical Engineering minor, Carnegie Institute of Technology, 1966
Licensing / Certifications	
Memberships	Member of the American Society of Mechanical Engineers Member of the Marine Technology Society

Publications

[1] Van Ryzin, J.C., Grandelli, P.D., Argall, R.S.K., Rizea, S.E., " Ocean Thermal Energy Conversion: The Cost Challenge." Offshore Technology Conference, May, 2009, Houston, TX.

[2] Van Ryzin, J. C., Grandelli, P., Lipp, D., Argall, R., "The Hydrogen Economy of 2050: OTEC Driven?" MTS-IEEE Oceans 2005, May, 2005, Washington, DC

[3] Van Ryzin, J. C., 1996. "Cold Water Pipe Technology: Hawaii Experience," US Navy-Industry Symposium on Ocean Thermal Energy Conversion, Kailua-Kona, HI.

[4] Van Ryzin, J. C., and Leraand, T. K., 1991. "Air conditioning with Deep Seawater; A Reliable, Cost Effective Technology" Proceedings of the IEEE OCEANS 91 Conference, Honolulu, Hawaii.

[5] Vuillemot, F., Van Ryzin, J. C., Resnick, A., 1988. "The HOST-STF (OTEC) Project in Hawaii: Planning, Design and Construction;" Pacific Congress on Marine Science and Technology, Honolulu, Hawaii.

[6] Lewis, L. F., Van Ryzin, J. C., Vega, L., 1988. "Steep Slope Seawater Supply Pipelines;" ASME 21st International Conference on Coastal Engineering, Spain.

25 additional publications...

Patents

- System for Extraction and Utilization of Oxygen from Fluids, Low-Drag Oxygen Extraction Gills.
- System for heat exchange in seawater by using finned aluminum extrusions.

RELEVANT WORK EXPERIENCE

Makai Ocean Engineering: Ocean Engineer since October 1973

Dr. Van Ryzin is the founder and former President of Makai Ocean Engineering and has been a Senior Ocean Engineer in every major program at Makai for the past 35 years. This work has included the development and design of deep water pipelines, the development of installation systems for deep water cables, design of seawater air conditioning systems, and the analysis and research on Ocean Thermal Energy Conversion systems.

OTEC-related projects in which Dr. Van Ryzin has been involved as a lead design engineer include:

- Principal Investigator of an ONR SBIR program (Phases I-III) for the "Integration and Optimization of Hydrogen Production with Ocean Thermal Energy Conversion Technology in Offshore Floating Platforms." This program assessed the technical, economic and business development of an offshore OTEC industry. It is currently in Phase III with the design and implementation of a 2-year heat exchanger development and test program.
- Support on the Lockheed Martin OTEC development program. Makai is a leading team member on the Cold Water Pipe, Platform, Cable, Pump, Heat Exchanger, and Systems Modeling teams.
- The design in 1979 of the cold water pipeline, mooring, and barge layout for Mini-OTEC, the world's first net-power OTEC demonstration by Lockheed and the State of Hawaii.
- Numerous deep ocean intake pipeline projects for deep ocean water applications including OTEC. This includes the mooring and pipe design for two floating OTEC research vessels, the design and installation of four separate, mile-long deepwater ocean intake pipelines with intake depths of 2200' and 3000', hydrodynamic tests on large scale pipes, and R&D programs for testing 8' diameter pipe installations in very deep water and the R&D design of an innovative, low-cost fabric OTEC pipe.
- The successful development, testing, and operation of a deep water cable laying control and simulation system that accurately placed and tensioned a cable within a few meters of its designated path in 1930 m water depth. Makai designs, develops and markets extensive software for the planning and at-sea real-time control of submarine cable installations.
- The engineering and economic analysis and design of a seawater air conditioning system that utilizes the deep cold seawater provided by Makai's pipelines. Makai provided the detailed design for a two-mile long, 63" diameter lake intake pipeline to provide 20,000 tons air-conditioning to Cornell University. Other AC systems have been designed for Bora Bora, Curacao, and Honolulu.

PATRICK GRANDELLI

Occupation	**Senior Ocean Engineer**
Experience	1998 - Present: Makai Ocean Engineering
Education	M.S. Ocean Engineering, University of Hawaii, 1997 B.S. Ocean Engineering with merit, United States Naval Academy, 1986
Licensing / Certifications	PADI-certified Rescue Diver
Memberships	Member of the American Society of Civil Engineers Member of the Marine Technology Society Member of the U.S. Naval Institute Lieutenant Commander in the U.S. Navy Reserve - Officer-in-Charge of the unit assigned to the USS Crommelin

Publications

[1] Van Ryzin, J.C., Grandelli, P.D., Argall, R.S.K., Rizea, S.E., " Ocean Thermal Energy Conversion: The Cost Challenge." Offshore Technology Conference, May, 2009, Houston, TX.

[2] Van Ryzin, J.C., Grandelli, P.D., Lipp, D., Argall, R. 2005. "The Hydrogen Economy of 2050: OTEC Driven?" Marine Technology Conference.

Patents

- System for heat exchange in seawater by using finned aluminum extrusions.

RELEVANT WORK EXPERIENCE

Makai Ocean Engineering: Ocean Engineer since October 1998

Mr. Grandelli is a senior engineer within Makai's OTEC program. He is a lead engineer in coordinating Makai's effort to support Lockheed-Martin's OTEC program where his expertise on heat exchanger testing, platform design, integration and optimization of OTEC systems, and OTEC operational experience are used. Mr. Grandelli served as lead systems engineer in Makai's Office of Naval Research project to investigate hydrogen production from offshore OTEC plants. He developed OTEC concepts, performed economic analysis on alternate approaches, did platform selection and platform dynamic analysis and technically and economically investigated new technologies. Previously, he served as lead operator and data analyst for a 50 kilowatt OTEC aluminum heat exchanger test and a 1MW Conceptual OTEC Design project performed for the Center of Excellence in Research for the Ocean Sciences (CEROS). Prior to working at Makai, Mr. Grandelli worked for the Pacific International Center for High Technology Research

(PICHTR) and operated and maintained a 250kW Open-Cycle OTEC plant. Mr. Grandelli's master thesis was on the design of a shore-based OTEC plant.

Mr. Grandelli performs structural and hydrodynamic analysis and design of high density polyethylene pipes during installation, mooring and anchoring. He also analyzes and tests the performance of heat exchangers, pumps, and performs engineering feasibility studies. He is Makai's expert in using OrcaFlex, a software system for dynamic structural analysis of pipelines, moorings and floating ocean systems.

Mr. Grandelli worked on design and/or construction observation for the 400mm diameter 900-meter-deep seawater intake pipeline for the new InterContinental Resort & Spa in French Polynesia, the 48" Waikiki Beachwalk sewer force main, the 63" Los Angeles Stone Canyon Water Quality Improvement Project, the 55" NELHA pipeline in Hawaii, Toronto's three 63" Deep Lake Water Cooling pipelines, and Cornell University's 63" Lake Source Cooling Pipeline. He performed the mooring analysis for two different projects to moor an OTEC barge in 1,200m deep water using HDPE pipe. He was responsible for the design of an underwater seabed-mounted 18" pump station and the Simulated Submarine Target, a large buoyant structure moored below the sea surface.

STEVEN RIZEA

Occupation	**Mechanical Ocean Engineer**
Experience	2005 - Present: Makai Ocean Engineering
Education	B.S. Mechanical Engineering, University of Florida, 2006
Licensing / Certifications	
Memberships	Member of the American Society of Mechanical Engineers NAUI Advanced Open Water Diver

Publications

[1] Van Ryzin, J.C., Grandelli, P.D., Argall, R.S.K., Rizea, S.E. 2009. "Ocean Thermal Energy Conversion: The Cost Challenge". Offshore Technology Conference.

RELEVANT WORK EXPERIENCE

Makai Ocean Engineering: Mechanical Ocean Engineer since August 2005

Mr. Rizea has performed tasks in the modeling and optimization of energy use and monetary cost in seawater air conditioning systems. He has also worked on thermodynamic and economic modeling and design of offshore ocean thermal energy conversion (OTEC) plants and in the design and analysis of deep seawater intake pipelines.

Mr. Rizea's work in OTEC focused on development of a thermodynamic and economic computer model of an offshore OTEC plant. He also assisted in plant design and layout. His responsibilities included thermodynamic analysis, computer code development and maintenance, cost estimation, and system modeling/optimization to support OTEC plant design.

GARY M. NOLAND

Occupation President, G. Noland & Associates, Inc.

Experience

2/07 to Present	President, G. Noland & Associates, Inc.
1/01 to 1/07	Ship Systems – Sunnyvale, Lockheed Martin Corporation
9/96 to 10/00	Business Development, Schafer Corporation
8/94 to 11/99	President, Procyon Power Systems Inc.
3/88 to 8/94	Marine Systems, Lockheed Missiles & Space. Co. Inc. (LMSC)
4/86 to 3/88	Program Manager, Ampex Corporation
5/83 to 4/86	Self-Employed Consultant to Government Program
1/80 to 5/83	Program Manager, Ampex Corporation
6/73 to 1/80	Engineer, National Security Agency

Education

BSEE, University of Maryland, 1973,
Member of Eta Kappa Nu, EE Academic Honor Society
Graduate Work in Electrophysics, University of Maryland, '75 thru '79
NSA Fellowship Program full time for school year '76 - '77

Licensing / Certifications

Memberships

Professional Interests

- Marine technologies (i.e. low motion hullforms, innovative propulsion, quiet auxiliary power)
- Renewable energy systems – Ocean energy systems
- Hydrogen as a clean replacement fuel for petroleum
- Fuel cell power systems and related system components

Patents

- Hybrid Electric-Combustion Power Plant (5,899,175),
- High Efficiency Oxygen / Air Separation System (5,706,675).

Military

- Army Security Agency '65 -'69
- Rank at Discharge:Staff Sgt. E-6
- Duties: Supervised approx. 20 enlisted personnel in the maintenance and repair of fixed site intercept equipment

RELEVANT WORK EXPERIENCE

G. Noland & Associates, Inc. was formed in early 2007 to provide program management and technical advice to the Lockheed Martin OTEC Program Office. This corporation owns the Next Generation OTEC System Design technology based on CO2 as a working fluid and a deep water condenser alleviating the need for movement of massive amounts of cold water to the floating OTEC plant. Expertise of other GNA Inc. associates includes OTEC

system design and modeling, renewable energy expertise, and financial structures and business planning for electric utility plants.
At Ship Systems – Sunnyvale, Lockheed Martin Corporation Gary provided assistance to the Sunnyvale Office of Ship Systems as a contract-hire through Echelon Service Co. for strategic planning, briefing development, proposal development, and generation of various proposals and White Papers.

Assisted Schafer Corporation's Energy and Environment group with business development. Gary managed all proposal activities to the US Government winning two out of three major procurements and acquisitions. Managed the "Gator Project" where two fuel cell powered utility vehicles were operated at the Palm Springs Regional Airport to assess emissions reductions and evaluate performance under sponsorship of the South Coast Air Quality Management District.

As President of Procyon Power Systems Inc., Gary formed Procyon Power Systems Inc (now dissolved) with Ambrose Manikowski and Allen McKee to develop an innovative hybrid power system for vehicles by combining fuel cells and IC engines. The objective was to substantially improve fuel economy while reducing emissions. Two patents were awarded: Hybrid Electric-Combustion Power Plant (5,899,175), and High Efficiency Oxygen / Air Separation System (5,706,675). A proprietary pyrolysis fuel processor was developed to safely extract hydrogen from petroleum fuels. A small scale fuel processor was built that produced high purity hydrogen from propane for laboratory use.

At Marine Systems, Lockheed Missiles & Space. Co. Inc. (LMSC) Gary's activities focused on new business development including proposal management, concept development, developing and conducting briefings to Navy customers, exploring new business opportunities related to ocean resources and the U.S. maritime industry. Specific accomplishments included:

- Managed the winning Mine Search Systems UUV proposal to DARPA
- Managed the winning Autonomous Control Logic proposal to the Navy
- Directed non-defense business initiatives in Marine Systems from '91 to '93
- Supported classified program from early '89 to mid '90
- Managed various small projects and proposal activities for Marine Systems from '91 thru '94.

While a Program Manager at Ampex Corporation Gary was responsible for transition of high performance disk drive system from engineer development into full production including class 100 clean room fabrication facilities, development of special purpose subassembly and final system test equipment. Implemented comprehensive Failure Analysis and Corrective Action program to reduce production failures and reduce total manufacturing time.

Gary was a Self-Employed Consultant to Government Program and supported a classified Government program as a directed subcontractor responsible for technical coordination between prime contractor and Navy laboratories to build and test specialized marine equipment. Gary performed the duties of Test Director for major system element evaluation and supported test and evaluation work at a Navy test range.

While a Program Manager with Ampex Corporation Gary was responsible for managing an engineering staff of 25 in the development of a specialized high-density digital data recording & retrieval system for a classified Government program.

As an Engineer with National Security Agency Gary's final assignment supported a program office for an ELINT data collection and analysis system. Previous assignment with research group developing equipment and concepts in the area of Fourier Optics and large time-bandwidth product signal recording, processing and analysis.

John Halkyard

Occupation	**President, John Halkyard & Associates Consultancy**
Experience	2007 – Present, President, John Halkyard & Associates Consultancy 2003 – 2007, Technip USA, Inc. 2000 – 2003, Aker Engineering, Inc. and Subsequent acquiring companies (CSO and Technip) 1989 – 2000, Deep Oil Technology, Inc. 1984 – 1988, Vice President, Arctec Offshore Corporation 1980 – 1984, Founder and President, Ocean Engineering Consultant, Inc.
Education	B.S., Engineering Science, Purdue University, 1966 S.M., Ocean Engineering, Massachusetts Institute of Technology, 1969 Sc. D., Ocean Engineering, Massachusetts Institute of Technology, 1972
Licensing / Certifications	**Registered Engineer:** M.E., California (since 1983)
Memberships	ASME-International Petroleum Technology Institute, Member of the Board of Directors, 2008 – 2011 Fellow, American Society of Mechanical Engineers (ASME) Chairman 2006-2006, Executive Committee, Offshore, Ocean and Arctic Engineering Division, ASME Chairman, OMAE 2007 Conference Past Chairman, Houston Technical Chapter, OMAE, ASME Member, Society of Naval Architects and Marine Engineers Past Member and Section Chair, Marine Technology Society, San Diego Past Member, Marine Board of the National Research Council, National Academy of Engineering Past Member of Marine Board Review Committee: Ocean Thermal Energy Conversion Technology

AN AREA OF EXPERTISE

Floater Development

In 1996, Oryx Energy Company and Consolidated Natural Gas Company installed the world's first Oil Production Spar Buoy in 2000 ft of water in the Gulf of Mexico. This concept for a stable floating production vessel was the invention of Ed Horton, founder of Deep Oil Technology. Dr. Halkyard served as Mr. Horton's chief technical advisor since 1989 and was responsible for proving the Spar concept and demonstrating its effectiveness. Dr. Halkyard organized and led several Joint Industry Projects, including, among other things, conducting of hydrodynamic model tests and correlation with theoretical estimates of the Spar's performance in ocean waves and currents, developing software for the integrated structural and hydrodynamic design of the Spar production system, and development and verification of mathematical models for the Vortex Induced responses of the spar in currents. A numerical program was developed to predict the Vortex Induced Vibrations and drag on a spar in a variable current and with the spar partially covered with helical strakes.

Dr. Halkyard was involved in the design and development of several of the critical components necessary for the spar concept to function as an oil production platform. For example, he received a patent for the a stress relieving joint

for the production riser pipes which allowed the pipes to pass through the keel of the spar where they would be subject to bending and wear from the relative motions of the spar in waves.

As Technical Director of DOT and subsequently as manager of R&D for Aker Engineering, Inc. after Aker acquired DOT, Dr. Halkyard has been responsible for the development of several additional deep water concepts and methods, some of which have resulted in additional patents.

Publications – Books and Monographs

[1] "Structural Analysis of Tension Leg Platforms", monograph included in *Tension Leg Platforms – A State of the Art Review*, American Society of Civil Engineers, 1990
[2] Contributing author to Handbook of Offshore Engineering, Chakrabarti, ed., Elsevier, 2005 (Chapters on Floating Offshore Platform Design and Risers)
[3] Dynamics of Floating Offshore Structures, authored by the late Subrata Chakrabarti, the chapters on floating offshore structure design are being edited by Dr. Halkyard.
[4] Principles of Naval Architecture, to be published by the Society of naval Architects and Marine Engineers. Dr. Halkyard is writing the chapter of floating structure responses.

Patents

- U.S. Patent 6,652,192, "Heave suppressed offshore drilling and production platform and method of installation", Nov. 2003
- U.S. Patent 6,299,383 , "Method for deck installations on offshore substructure ", Oct. 2001
- U.S. Patent 6,206,614, "Floating offshore drilling/producing structure", Mar. 2001
- U.S. Patent 5,924,822, "Method for deck installation on an offshore substructure", July, 1999
- U.S. Patent 5,683,205, "Stress relieving joint for pipe and method", Nov. 1997

RELEVANT WORK EXPERIENCE

John Halkyard is currently the President of John Halkyard & Associates Consultancy.

At Technip USA, Inc John was the Chief Technical Advisor in the Floating and Fixed Facilities Product Group. John provided technical advise and support for projects and R&D efforts, particularly in the areas of hydrodynamics, model testing and systems global analysis. Spearheaded application of Computational Fluid Dynamics to the problems of spar and riser vortex induced vibrations.

In his position at Aker Engineering, Inc. and Subsequent acquiring companies (CSO and Technip), John was Vice President, Product Technology and Deepwater R&D. John planned and implemented an $3MM/annum R&D program in a large contractor organization which had no previous R&D department. Hired a staff and lead development of several new products. Presently Chief Technical Advisor for the Floaters Products Division of Technip Offshore, Inc.

John was a Consultant and later Technical Director for Deep Oil Technology, Inc. and responsible for analysis and testing of Spar Floating Production Systems. Plan, organize and conduct experiments and develop computer programs for spar and riser analysis. Prepare and analyze novel designs for new applications, especially North Atlantic and Norwegian Sea projects. Manage R&D projects with industry participation.

As Vice President for Arctec Offshore Corporation Market, John managed hydrodynamic and structural testing related to naval and offshore projects. And managed numerous test programs for offshore structures, ships and submarines in the AOC model basin in Escondido, California. Principle among these was a comprehensive series of tests for the first floating production system in the Gulf of Mexico, The Placid GC29 Semi-submersible.

John was Founder and President of Ocean Engineering Consultant, Inc. John started and managed has own consulting company working on projects ranging from ocean mining, offshore structures and high performance pumping applications. Prepared studies for mining methods of cobalt rich oceanic crusts and ocean sulfides. Assisted in the design of tendons for Tension Leg Platforms, especially the analysis and testing of the tendons for fatigue and fracture. Initiated major research program on the Inspectibility of TLP Tendons. Also prepared business plan and helped develop an energy efficient system for desalination using reverse osmosis and a patented energy recovery pumping system (Varipump Corp.).

PAUL S. SMITH

Occupation	**Sr. Principal, Naval Architecture & Director of Finance**
Experience	1975 - 1977 US Army Corps of Engineers, Marine Design Center 1979 - 1982 Ocean Salvors Company 1982 – 1986 Tracor Marine Inc. 1986 – 1992 The Hudson Companies 1992 – 2002 MARCO Pollution Control 2002 - present The Glosten Associates, Inc
Education	University of Michigan, BSE, Naval Architecture & Marine Engineering, 1975 Massachusetts Institute of Technology, SM, Ocean Engineering, 1979 University of Washington, MBA, 2000
Licensing / Certifications	Hazardous Material Specialist (29 CFR 1910.120)
Memberships	Society of Naval Architects and Marine Engineers, Past Chairman PNW Section American Society for Testing & Materials, Past Chairman, Panel F20.12 (Oil Spill Recovery)

RELEVANT WORK EXPERIENCE

Paul Smith has thirty years of international experience in shipbuilding, marine salvage, environmental response and ocean operations. He brings skills in diverse management and marine engineering disciplines, with particular skill in complex ocean operations. Joining Glosten in early 2002, he was part of the project team moving thousands of tons of drilling and process equipment to a remote location in the Russian Far East. In 2003, he was promoted to Principal and Finance Director. He helped establish the company's practice areas of salvage engineering and logistical planning. He has assisted as a salvage engineer in more that a dozen cases. He leads the practices in logistics, mooring design, marine towing, risk assessment, acquisition management and financial modeling, with focus on the energy and public sectors.

Paul has assisted with the relocation of a concrete island drilling structure from Korea to Russia, a transatlantic delivery of a bare-deck semisubmersible platform and the delivery and installation of two FPSOs from Korea to Angola. He has prepared documents for competitive acquisition of towing services, installation of permanent moorings and the construction of new vessels. He has also served clients on-site, embedded as a member of their management team during project execution.

He has led or has served as a subject matter expert in more than a dozen risk assessment workshops associated with unique marine operations. His financial models for marine transportation and intermodal systems have been used as decision-making tools by companies and government agencies.